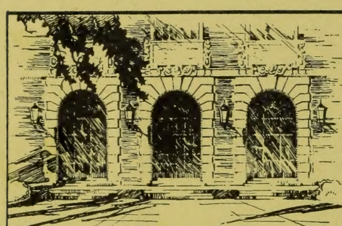

Visual Acuity c. Colours - Dow, 233.

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Screening - Darch 83, 173;

Factory Lighting - Conseil d'Hyg. 292, 319; British 373, 466; Marks, 752

Daylight - Waldram, 469.

JAN. to DEC., 1909.

The ILLUMINATING ENGINEER

THE · JOURNAL OF SCIENTIFIC

ILLUMINATION

EDITED · BY · LEON · GASTER

Official Organ of the

Illuminating Engineering Society.

(Founded in London, 1909.)

VOL. II.

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The ILLUMINATING ENGINEER

ELECTRICITY · ACETYLENE · OIL · GAS

Edited by LEON GASTER

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EDITORIAL.

The Memorial to Sir George Livesey.

The decision of those representing the gas industry to found a lectureship in memory of Sir George Livesey will be generally approved of as a method of recognition in accordance with his expressed aims and aspirations when alive. In founding a lectureship the profession is bestowing on the young engineers in this country a gift of special value—education, the benefits of which they will retain throughout life.

But it must also be recognized that the manufacturers in this country have a duty to perform in order to secure that this gift is appreciated as it deserves. It is hardly to be expected that students will be prepared to spend a considerable amount of time and money on education of this description unless they feel that their efforts and enterprise will be suitably recognized when they go into practical work.

Therefore, it behoves manufacturers to furnish the required stimulus by insisting upon a higher standard of qualifications in those who are to occupy responsible positions, and to reward these qualifications with suitable remuneration. In these days of keen competition it is the man with most knowledge who is best able to withstand and combat ignorance and prejudice. It is also to be hoped that the subject of illumination will receive the attention it deserves. If there is one thing more than another in which the Continental system of education excels, it is the appreciative attitude of the industry towards educational institutions; naturally this spirit is a matter of gradual growth, and is due to a great extent to the fact that leaders of industry there are, in the main, themselves college-bred men.

We are glad to see that there are indications of the development of a similar feeling in this country.

Reliable Information on all Branches of Illumination Desirable.

Some inquiries which we have recently received suggest one point on which the attitude of this magazine

may need elucidation. In our journal we desire to review the progress of all the different systems of illumination, and our columns are impartially open to the discussion of all sides of these questions.

Although, therefore, we think that we can with justice claim to follow the developments of illuminants more closely than a journal not specifically devoted to illumination, it is necessary to draw a somewhat rigid line between matters of illumination pure and simple and those more or less closely connected processes of manufacture, &c., in order to make any effectual attempt to follow the subject which fall strictly within our province. These remoter matters, relating, for instance, to the details of the generation of gas and electricity, heating and cooking, &c., we naturally leave to be dealt with by the many existing technical publications, who make it their business to do so.

It is therefore no reflection on our magazine to explain that a gas or electrical engineer can naturally not expect to find in our columns his own field covered with the completeness which is characteristic of the trade journals devoted to his interests. On the other hand, we claim that our international nature and impartial attitude towards matters of illumination enables us to deal with this subject in a spirit, and with a completeness, that no other existing European journal attempts; and, in addition, we wish to repeat that it is our desire to induce the lighting engineer in one field to follow the progress in others.

The facilities which our magazine provides in this direction have been recognized by many engineers, even those who at present do not profess to be connected with more than one aspect of illumination, to be an exceptionally valuable feature.

Church Lighting.

In the present number we make special reference to this matter, not with the object of making specific recommendations as yet, but merely for the purpose of drawing attention to the many questions in dispute, and affording an opportunity for the exchange of views of those interested. We hope to deal with certain specified cases of church lighting in greater detail in subsequent numbers.

We may, however, take this opportunity of expressing our conviction that a great deal more might be done to improve the appearance of the interiors of national buildings of exceptional importance than is done at present. Without giving any definite opinion, for instance, on the system of lighting in use in such buildings as Westminster Abbey, St. Paul's, the Westminster Cathedral, and the many other churches and cathedrals in different parts of Great Britain that are justly world-famous, one feels that Westminster Abbey, as the writer of one of the articles in the Special Section points out, stands in some respects in a unique and exceptional position. This building is not only a church of singular architectural beauty. It is more than that. It is the National Museum in which we endeavour to form a collection of objects and mementoes that recall the great traditions of the past, and it is the scene of coronations, funerals of national heroes, and other events of the very highest national importance.

Under these circumstances the lighting of such a building deserves very careful consideration, for it is governed by conditions such as probably no other building in the kingdom presents. Naturally the system of illumination must, first and foremost, be in sympathy with the historic associations of the building. Yet since some alterations seem to have recently been carried out in the conditions the illumination might well receive such expert attention as to convince the public that we have got the very best conditions possible in the light of our

present knowledge. There are, of course, many other national buildings that deserve attention of a similar kind.

Are we justified in feeling that the present conditions of illumination employed are such as their recognized value demands ? A perusal of some of the recent comments in the press on this point leads one to form an impression that there is a general belief that more might be done to satisfy all requirements.

The Association of Carlighting Engineers.

Last November the first annual meeting of the above newly-constituted association took place at Chicago. We wonder what will be the impressions of those who formerly doubted the advisability of forming an Illuminating Engineering Society, when witnessing the birth of what they would presumably consider a society with a yet more limited field of action !

The attendance at the first meeting seems to have been very satisfactory indeed, over 200 members being present and papers of unusual interest and very stimulating to discussion were presented. We ourselves recognize that there is room for individual effort of this description. The indirect consequences of providing really good illumination in trains and vehicles is rarely sufficiently realized. To many people, who make daily journeys by train, tube or 'bus, the conditions of the light make all the difference between tedium and comfort. In the present restless age people are not content to sit idle for a long journey to the same extent. They read, unless the light is so extremely weak and flickering as to render it literally impossible for them to do so.

To our mind the success of certain electric trams and buses is due in no small degree to the provision of an interior illumination that enables people to read in comfort. And apart from this use of light, who can dispute the value of the illumination so utilized from the advertising standpoint ?

Another matter that deserves attention is the influence of illumination on traffic. Apart from the necessity for a good general illumination, the correct arrangement of headlights, &c., informs pedestrians of the coming of a vehicle, and also enables them to determine what the nature of the vehicle is. It is only a few years since it became obligatory for all vehicles to carry lights, and the increasing speed of traffic has had the effect of drawing special attention to the importance of adequate arrangements in this respect. Moreover, it must be remembered that the lighting of a vehicle is in some respects the most valuable method of drawing the attention of pedestrians. The sounding of a bell or horn informs them that a vehicle is approaching, but gives no clear information as to its distance away ; a glance is necessary to determine its position, and if the headlights are not satisfactory the result is bewilderment.

In the case of motor-cars, &c., in which the headlights are also called upon to illuminate the road in front it is still more difficult to meet the exact requirements. In many cases, however, it is probable that a source of greater extent and less intrinsic brilliancy might profitably be used as headlights. There is also room for the more complete illumination of suitable signs giving clear information as to the route, &c., and we already see evidence that this is becoming increasingly realized. For instance, the number and colour of the headlights is now made use of to indicate the route of an approaching tram.

Bearing in mind the many interesting aspects of the subject and the important role played by illumination in trams, trains, and vehicles, it seems to us that an association taking up these points in detail might do very valuable work.

All these are matters to which we should like to draw the attention of

directors of omnibus, motor car, &c., companies, for they suggest methods that might lead to an increase in traffic and revenue. It is probable that the small expense incurred in utilizing light in the manner indicated would be amply compensated by the greater number of passengers attracted.

The Illuminating Engineer.

During the past year people in this country have had an opportunity of satisfying themselves as to the value of the work the illuminating engineer seeks to carry out, and the time is not far distant when the formation of a society will enable these questions to be discussed yet more fully.

The moment is, therefore, ripe to refer to one matter on which a clear understanding is exceedingly desirable, and which has recently been the subject of comment in our contemporary *The Illuminating Engineer* of New York. In advocating the formation of such a society we have no desire to do more than provide a common platform where all those interested in illumination may be able to express their views in a free and informal manner, and membership of such a society cannot, at the present time, be regarded as any claim to professional distinction. We naturally hope that in times to come, when the subject of illumination has been thrashed out in detail to a far greater extent than at present, "expert illuminating engineers" will have a professional existence and will, even though few in number, be entitled to claim the distinction that the name implies.

But at the present moment, though a man may be a member of the "Illuminating Engineering Society," this will not entitle him to be termed an "Illuminating Engineer" unless his qualifications are of a very exceptional nature, and the number of experts in this country who are entitled to claim the title with any approach to justice are, to the best of our knowledge and experience, few indeed. And the same view of the matter is held in the United States. For this reason the society has been termed the "Illuminating Engineering Society," and not the "Society of Illuminating Engineers." The *subject* of illuminating engineering may be said to have proved its claim to existence. But the expert "Illuminating Engineer" is a creation of the future, and any attempt to force his existence in name only, without the necessary qualifications, can only bring the title into disrepute.

This point is the more to be insisted upon because of the wideness of the field that the subject of illuminating engineering must necessarily cover, and the great number of members of different professions and trades that, experience has shown, will probably become interested in the subject. Naturally at present each representative can only judge of the relatively narrow aspect of the subject with which he is associated, and it can only be by degrees, and by the frank interchange of opinions between all such interested experts, that the illuminating engineer, in the true sense of the word, can ultimately be developed. A clear understanding on this vital point from its very beginning will no doubt do much to assist the formation of the Society which we are strongly advocating.

The function of such a society, therefore, ought, we think, to be merely the provision of an impartial platform on which this free interchange of views can take place; it should be realized that membership should not demand the possession of certain qualifications except an interest in the objects of the society; in this respect the Illuminating Engineer Society would resemble other flourishing and useful scientific gatherings existing in this country.

LEON GASTER.

Review of Contents of this Issue.

Mr. A. P. Trotter (p. 1) continues his discussion of various well-known types of photometers. In the present instalment he describes some different forms of RITCHIE PHOTOMETERS, and gives some account of the practical details on which the sensitiveness of such instruments depends.

Dr. W. Voege (p. 10) contributes an account of some researches on a METHOD OF COMPARING THE "WHITENESS" OF THE LIGHT from different illuminants, and forming an idea of their temperature by comparing the total luminosity with that in the red.

He employs a thermopile, the face of which is subjected to the rays of the source of light after they have passed through a special heat-absorbing solution, and then through clear or red glass respectively. By this means, it is contended, the effect of the dark heat rays is minimized, and the deflections of a galvanometer attached to the thermopile can be regarded as proportional to the intensity of the light in the two cases; the ratio of the deflections is, therefore, a criterion of the degree of *whiteness* of illuminants depending upon temperature-radiation only.

Mr. J. Rosemeyer (p. 15) completes his article on MODERN ARC LAMPS AND THEIR APPLICATIONS. He discusses some of the conditions favourable to the use of efficient enclosed arc lamps, and gives some account of recent flame arc lamps in addition. Finally he completes the article with a reference to some special uses of arc lamps, *e.g.*, for photography and for therapeutic purposes.

Dr. C. V. Drysdale (p. 20) continues his contributions dealing with the LAWS AND MEASUREMENT OF RADIATION. He makes reference to the work of Langley and gives a series of diagrams illustrating the distribution of energy in the spectra of incandescent illuminants at different temperatures. He also explains the nature of Draper's and Kirchoff's laws and their effect upon the radiating qualities of incandescent solids, from the point of view of light-production.

An article by **Our Berlin Correspondent** (p. 23) discssses the recently suggested TAX ON GAS AND ELECTRICITY in Germany. He contends that the imposition of such a tax would be a hardship to the poor consumer, since light is now to be regarded as a necessity, and would also be prejudicial to the development of many industries. In addition, he considers that the administration of the tax would demand the services of special officials with technical knowledge, and therefore would consume a great portion of the revenue derived.

Among other articles in this number may be mentioned that on the POSSIBILITIES OF LIGHTING BY CARBON LAMPS (p. 25), in which the author gives a number of data illustrating the behaviour of 100-volt and 200-volt carbon filament electric lamps run at different pressures, and the connexion between "useful life" and efficiency of such lamps.

Some account is also given of the Annual Convention of the COMMERCIAL GAS ASSOCIATION in Chicago this year. Several papers are abstracted, dealing with the organization of the business of a gas company; and the necessity of paying attention to the point of view of the consumer, and listening patiently to his complaints, if well grounded, is emphasized in a paper by **Mr. C. W. Hare** (p. 29).

Another recent gathering of exceptional interest, to which reference is made, is the first annual meeting of the ASSOCIATION OF CAR-LIGHTING ENGINEERS (p. 32). A number of papers on different subjects were read relating to various aspects of train- and tram-lighting.

The **Special Section** (p. 33) on this occasion is devoted to the subject

of CHURCH LIGHTING. **Mr. G. A. T. Middleton** contributes a brief review of the question from the architect's standpoint. He discusses the requirements of religious worship in the matter of illumination, pointing out that tradition demands a subdued effect, and that under these circumstances a relatively low illumination is all that is required on the books of the congregation.

Another article on the same subject (p. 37) contains a number of illustrations of gas and electrically lighted churches in England and on the Continent. Special attention is also drawn to the need for taking very special care in the arrangements for the lighting of such buildings as Westminster Abbey, that are not only churches of great architectural distinctions, but also buildings of great national importance.

The LIGHTING OF CHURCHES BY ACETYLENE is also dwelt upon by a French correspondent (p. 53), and is illustrated by reference to the arrangements at the Church of St. Germain. A special field for acetylene lighting is its application for the creation of special decorative effects on fête days, cylinders of liquid acetylene being brought in and connected with the existing piping for this purpose.

A paper by **Mr. E. G. Perrot** (p. 50), recently delivered before the Illuminating Engineering Society in the United States, also makes special reference to the application of electric lighting in churches for the production of SPECIAL EFFECTS IN CHRISTMAS CELEBRATIONS.

Mr. J. B. Fulton, A.R.I.B.A. (p. 57), contributes an interesting account of the system of illumination in use in the famous **Church of Santa Sophia** in Constantinople, which some have declared to be the most exquisitely proportioned interior in the world.

The lighting by many small oil-lamps, Mr. Fulton states, has a wonderful decorative effect, but the *illumination*, in the strict sense of the word, is weak, and it is possible that a powerful source in the great central dome might be used with advantage.

Among other items in this number attention may be drawn to the paper by **Mr. F. E. Cady,** before the Illuminating Engineering Society, dealin a very exhaustive manner with the RELATION BETWEEN THE P.D. AND CANDLE-POWER of different types of GLOW LAMPS.

An article (p. 22) discusses the value of good illumination to the physician engaged in DIAGNOSIS BY ARTIFICIAL LIGHT, a suggestion by **Mr. Cressy Morrison** being referred to, to the effect that acetylene light is best for this purpose, on the ground of its presumed close resemblance to daylight.

An article by **Prof. L. Weber** (p. 65) discusses the important question of the NOMENCLATURE OF THE UNIT OF ILLUMINATION. He considers the relative claims of the terms "Lux" and "Meterkerze," and arrives at the conclusion that the latter term, which is already widely recognized in Germany, is preferable at present; the term "Lux," he says, would have advantages were general agreement come to on the subject of the unit of light; but of this there is unfortunately no immediate prospect.

The **Correspondence** columns contain a letter from **Mr. P. J. Waldram** (p. 64) on the subject of DAYLIGHT ILLUMINATION, the author discussing a suggestion in the recent paper by Mr. L. J. Lewinson (vol. i. p. 943) to the effect that a higher illumination is necessary to read by, in the case of daylight conditions.

At the end of the number will be found the usual **Review of the Technical Press** (p. 66) and the **Patents** (p. 70).

TECHNICAL SECTION.

[*The Editor, while not soliciting contributions, is willing to consider the publication of original articles submitted to him, or letters intended for inclusion in the correspondence columns of 'The Illuminating Engineer.'*

The Editor does not necessarily identify himself with the opinions expressed by his contributors.]

Illumination, Its Distribution and Measurement.

BY A. P. TROTTER,

Electrical Adviser to the Board of Trade.

(*Continued from p.* 978, Vol. I.)

The Ritchie Photometers.—The Bouguer photometer may be called a table photometer, and the arrangement of the Harcourt form of it for gas testing is essentially one for a table; the two lights and the screen form the corners of a triangle. It seems that the arrangement of the two lights with a photometer moving in a straight line between them first occurred to William Ritchie, and he modified the Bouguer photometer with this object.

On Friday, May 12th, 1826, at the Royal Institution, London, where he afterwards held a professorship, "Mr. Ritchie produced two or three forms of his very convenient new photometer, founded on the principles of Bouguer, an account of which has been read to the Royal Society of Edinburgh."*

The paper† begins by reference to "the celebrated Bouguer," who first discovered the important fact that the eye can detect a very small difference between two similar illuminated surfaces, "the only principle which has yet been applied with any degree of success in determining the relative illuminating powers of artificial flames." The instrument "consists of a rectangular box, about an inch and a half or two inches square, open at both ends, and blackened within for the purpose of absorbing the stray light. Within the box are placed two rectangular pieces of plane mirror, forming a right angle with each other.....In the upper side, or lid of the box, there is cut a rectangular opening, about an inch long, and one-eighth of an inch broad. This opening is covered with a slip of fine tissue or oiled paper. In the annexed figure ABCD is

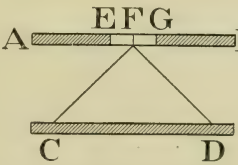


FIG. 53.—Ritchie's Photometer.

the box; CF, FD, the two plane mirrors; EG the rectangular opening. ....The rectangular slit should have a small division of blackened card at F, to prevent the possibility of the lights mingling with each other, and thus affecting the accuracy of the result.

In using the instrument, place it in the same straight line between the antagonist flames, at the distance of 6 or 8 ft. from each other; move it nearer the one or the other, till the disc of paper appears equally illuminated on each side of the middle division, and the illuminating powers of the flames will be *directly* as the squares of their distances from the

* *The Quarterly Journal of Science*, Royal Institution, London, Vol. xxi., 1826, p. 333. A concise description of the instrument is given on p. 376 of this volume.

† *Trans. Roy. Soc. Edin.*, Vol. x. p. 443, May 1st, 1826.

middle of the photometer. In moving the instrument rapidly between the two lights, we very soon discover a boundary, on each side of which the difference between the illuminated discs becomes quite apparent. By making the instrument move from one side of this line to the other, and gradually diminishing the lengths of the oscillations, we at last place it almost exactly in its proper position. It is very convenient to have a board of the same breadth as the instrument divided into equal parts.....

Instead of the two mirrors I sometimes use the same instrument, with a piece of white paper pasted on the faces of the mirrors, or on a piece of smooth wood forming, as before, a right angle. In this case the illuminated discs are viewed through the rectangular opening in the lid, without the intervention of the tissue or oiled paper.....

When the colours of the flames are different it is very difficult to ascertain the place of equal illumination. We can, however, as before, find the space over which the instrument moves before we discover an obvious difference between the illuminated halves of the oiled or white paper. We must then take the middle of this space, which will, even in that difficult case, give us a very good approximation to the truth. The same method was also used by M. Bouguer.....When one of the lights is of a fine white, and the other of a dusky red or blue colour, I prefer the following contrivance.

Procure a piece of fine white paper, and get it printed with small distinct type. Paste it on the rectangular opening in the instrument, which in this case may be somewhat enlarged. Brush over the paper with fine transparent oil.....Place the instrument between the flames, and cause two assistants to move them in either direction till you can just read them continuously along the paper with the same ease."

Some practical details of the original pattern with mirrors are worth considering. If mirrors making a right angle are used, and are arranged as in Fig. 54, the observer being in the direction O, and if the translucent screen is removed, two images of the lamps are seen in the directions A and B,

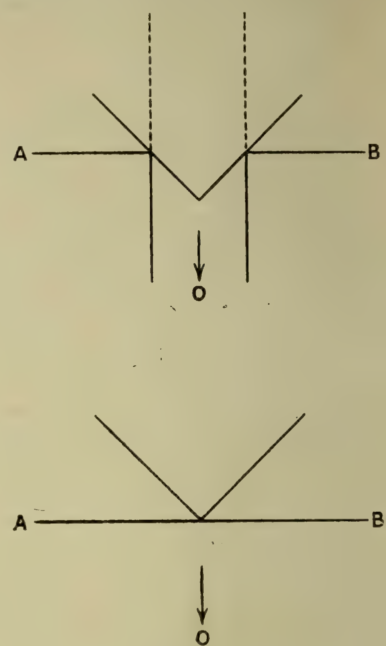


Fig. 54.

separated by a distance equal to twice the projection of the meeting edges of the mirrors in front of the line joining the centres of the lamps. This is of no practical importance. But owing to the thickness of the glass, there is an unpleasant shadow on the translucent screen, and with right-angled mirrors this cannot be avoided. The remedy is to set the mirrors at an

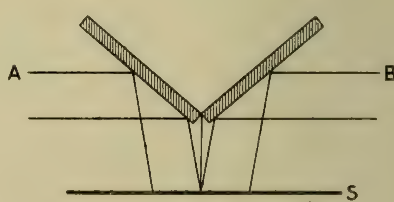


Fig. 55.

angle of about 100 degrees, as in Fig. 55. The beams reflected from them, therefore, converge and make an angle of about 20 degrees, as they do in the Harcourt photometer. The position of

the translucent screen S can then be adjusted so that the illuminated patches meet with a precision that would satisfy a Rumford or a Foucault. Not only can they be thus well fitted together, but, unlike the Rumford, Foucault, or Harcourt photometers, the movements necessary for balancing lights of different candle-powers have no effect on this fit, and no fresh adjustment need be made. By applying a pair of suitably cut screens to the edges of the mirrors, the meeting line may be made zig-zag. In Fig. 56 A shows the front view of the mirrors, and B the appearance of the screen when out of adjustment. Some such device is often used in photometers, but the advantage is a matter of personal preference.

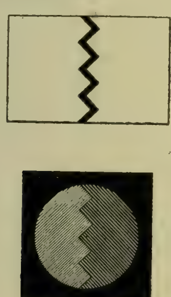


Fig. 56.

A photometer of this kind is excellent for ordinary work. Ritchie used it on a table with the screen horizontal, but it is more convenient to set the screen vertical, and to use it on a graduated bar. The slit, one inch by an eighth, may be replaced by a circular hole about 1 in. (25 mm.) in diameter. It is a mistake to use a large screen, partly because it is difficult to secure uniform illumination, and partly because the attention is generally directed to one part of the dividing line, and the rest of the screen is comparatively useless. An eye-piece such as Foucault used in later forms of his photometer is unnecessary. This kind of photometer can be better used with both eyes. The use of an eye-piece may introduce physiological complications. A little stray light in the room falling on the outside of the screen dilutes both sides alike, and though it may reduce sensitiveness, need not cause error. A very useful photometer can be made in an ordinary match-box.

It is interesting to find that among the numberless forms of photometers, Dr. C. V. Drysdale* has selected the Ritchie reflecting photometer as best suited for his research on the mechanical equivalent of light. He substituted totally reflecting prisms for the mirrors, and for hetero-chromatic work he employs a discrimination diagram, which, so far as it consists of letters, is exactly what Ritchie used for the same purpose.

The second form of Ritchie's photometer, namely, the two white screens set at an angle has given rise to so many different modifications, that some consideration may be given here to the angle of the wedge.

* *The Illuminating Engineer*, p. 544.

(*To be continued.*)

The National Unit of Light in the United States.

It will be remembered that the resolutions proposed by a Committee on the above subject, as presented by Dr. Humphreys at the recent Convention of the Illuminating Engineering Society (see *The Illuminating Engineer*, November, p. 919), were to be put before the American Gas Institute for acceptance at their annual meeting.

It appears, however, that the Institute prefer not to come to an immediate decision, on the ground that the data available are not yet complete. A pentane lamp, representing the United States standard, has been sent to the Bureau for comparison with the British standard, through the intermediary of calibrated glow-lamps. But, owing to the abnormal atmospheric conditions of the last few months, the Director does not yet feel justified in making a definite report. Immediate decision is, therefore, postponed, the matter being considered by a Committee of the Gas Institute, acting in conjunction with the Bureau of Standards.

A Simple Apparatus for the Examination of the Colour and Quality of Radiation Furnished by Artificial Sources of Light.

By Dr. W. Voege.

(*Physik. Staatslaboratorium*, Hamburg.)

Among the existing problems in radiation and photometry that are as yet unsolved may be mentioned that of measuring the intensity of the light of any particular colour in an illuminant by a simple method, and the expression of the result as a simple number, just as the total intensity of a source is expressed in Hefner units.

A process has been suggested by Steinmetz, according to which light of three specified wave lengths in the spectrum of the mercury lamp is thrown upon the photometer-screen, the intensity of each element being adjusted, until the colour of the resultant light resembles that from the source to be tested ; but this method would lead to very great difficulties in practice.

One reason why it is so difficult to devise a common method of measurement, applicable to all sources, lies in the fact that the principles, underlying the production of light, are very different in individual cases, sometimes depending on temperature-radiation pure and simple, sometimes on luminescence, and, most frequently, both. For instance, the light from the glowing tips of the carbons in a flame arc is generated by incandescence, but the light arising from the arc itself is due to a luminescence effect. In the case of the incandescent gas light, and even the electric glow-lamp, the selective radiation of the luminous material plays a certain role in the total effect.

The solution of the problem before us demands first of all the separation of luminous sources into two chief classes, depending mainly on temperature radiation and luminescence respectively, which can be treated separately, and lamps of the same class being broadly comparable with one another.

As is well known, the energy maximum of an incandescent material moves towards the short wave-length end of the spectrum with rising temperature, in the case of pure temperature radiation. This alteration in the position of the maximum carries with it a corresponding accentuation of the blue and green as compared with the red. In the case of pure temperature radiation, therefore, the condition of incandescence of a material is a criterion of its colour value, and, as the writer has shown previously,* one can determine and utilize the heating effect of a given luminous intensity in this manner.

The higher this value the redder the quality of light, and, conversely, the smaller it is the whiter does the light appear to be. And the nearer this quantity approaches that of daylight the more perfect does the revelation of different colours, illuminated by the source, become.

An equally effective method, theoretically, would be merely to determine the absolute temperature of the glowing body. Unfortunately the exact determination of this quantity is a difficult process, and like the above method of determining the heating value of light of a given intensity, can hardly be regarded as practically effective.

In what follows the author proposes to describe a process which enables small differences in the temperature of incandescence (and hence also in colour value), to be determined with great ease and accuracy ; this can be applied to various types of glow-lamps, and the colour of the light yielded by different varieties of petroleum, &c.

The method consists essentially of the comparison of the integral luminosity of a source with that

* *Jour. für Gas.*, 1905, p. 513.

transmitted through a sheet of red glass.

This comparison is, however, not accomplished by photometric means, but through the agency of a thermopile. A photometrical estimation of the intensity of the red element is very inaccurate, partly on account of the actual difficulty of the comparison, and partly because the red is such a small fraction of the total light.

On the other hand, the use of a Rubens thermophile, having 20 iron-constantan couples, and equipped with a collector, is extremely sensitive.

If, now, the terminals of the thermophile be connected to a mirror-galvanometer, and we observe, first, the deflection due to the rays of the illuminant passing through *clear* glass, and, secondly, the corresponding deflection due to the rays transmitted through *red* glass, it will be found that the results do not differ very materially in the two cases. In reality the transmitted rays include the relatively large amount of energy in the form of dark heat rays, which do not contribute to the luminous effect, and thus the results would be quite inaccurate, and would bear little relation to the light emitted.

The measurement, however, becomes serviceable if one arranges to absorb the dark heat rays on their way to the face of the thermopile. This is accomplished by introducing in the course of the rays a depth of 14 mm. of solution of ferro-ammonium sulphate ($Fe\ SO_4\ [NH_4]_2\ SO_4 + 6\ H_2O$). Such a depth of this concentrated solution appears slightly greenish by transmitted light, and suffices to absorb the dark heat rays completely.

We now observe a marked difference in the deflection obtained as a result of examining the rays after passage through the transparent glass and after passage through the red glass respectively. For instance, when the light from a carbon filament 110-volt lamp is so treated, we obtain,

For the total radiation, $ag = 99{\cdot}1$ divisions.
,, red ,, $ar = 48{\cdot}0$,,

The ratio $\frac{ag}{ar}$ can, therefore, easily be determined with the requisite exactitude, and can be applied to the comparison of sources of the same type, such as, for instance, the newer incandescent glow-lamps, or to the study of the illuminating effects of differing qualities of petroleum, naturally using the same type of burner.

The general arrangement of the apparatus will be understood from Fig. 1. In the tin box B is placed the thermopile S, with the funnel F. In front of the latter are placed two absorption-vessels, A_1, A_2, each containing 7 mm. depth of concentrated solution of ferro-ammonium sulphate. Between these two vessels may be inserted either a sheet of clear glass or a red glass G. It is convenient to place a reflector R behind the source of light L, of such a variety as to return as much of the light as possible. Any suitably sensitive mirror-galvanometer can be used, but its resistance should be as low as possible. The writer employed a Hartmann and Braun mirror-instrument, having a resistance of 5·5 ohms, and giving a deflection of one division for a current of 3×10−8 amperes. In order to obtain large deflections one naturally selects lights of high candle-power wherever possible.

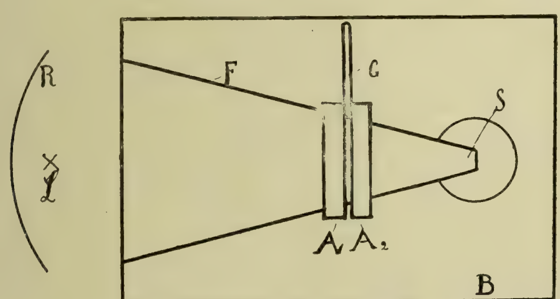


FIG. 1.—General Arrangement of Apparatus.

The following table gives the results obtained by testing a carbon filament 25 H.K. 110-volt lamp at different pressures :—

Pressure. Volts.	Deflections. *ag*	*ar*	*ag/ar*
85	27·6	14·7	1·88
90	36·8	19·4	1·895
95	48·5	25·4	1·91
100	62·0	31·9	1·945
105	79·0	39·6	1·995
110	99·1	48·0	2·062
115	122·3	58·0	2·11
130	207·0	90·0	2·30

In Fig. 2 a curve, plotted from these results, is shown.

It will be observed that the quantity *ag*, corresponding to the total radiation, increases more rapidly than *ar*, which would naturally be expected, from the fact that the short wave-length radiation increases most rapidly with rising temperature. The change of the ratio *ag/ar* is also shown. The position of the points speaks well for the accuracy of the method.

It may, however, be pointed out that the values of *ag/ar* obtained in this way are, naturally, only of value considered *relatively*, and are only intercomparable when obtained under the same conditions and with the same apparatus. The absolute value of this ratio naturally depends upon the nature and thickness of the absorbing liquid, and the transparency of the glass used.

In these experiments, investigations were carried out upon the newer glow-lamps, arc-lamps with pure carbons, lamps using various kinds of petroleum, incandescent mantles, and daylight (from a clouded sky). Table 1 contains the results of these experiments.

The table makes it clear that the light from the new glow-lamps is whiter than that furnished from those having carbon filaments; metallic filament lamps also differ to some extent from one another. It is remarkable that the factor $\frac{ag}{ar}$ is 2·38 in the case of the tantalum lamp, while for the wolfram lamps, it is, on the average, about 2·30. Again in the case of the Nernst lamp a distinct difference is discernible between the condition of the light obtained by the use of frosted and opal globes respectively. In the latter case the factor $\frac{ag}{ar}$ is smaller, and therefore, presumably, the light somewhat redder than when frosted globes are used.

TABLE I.

	P.P.	Intensity.	*ag.*	*ar.*	*ag/ar.*
Carbon Filament Glow-Lamp ...	108 Volts	25	82·9	40·2	2·06
Tantalum ,, ...	108 ,,	25	57·2	24·0	2·38
Osmium ,, ...	40 ,,	32	71·4	31·2	2·29
Osram ,, ...	112 ,,	25	52·0	22·5	2·31
Sirius ,, ...	110 ,,	25	48·2	20·0	2·41
Bergmann ,, ...	110 ,,	32	56·6	25·4	2·23
Just-Wolfram ,, ...	110 ,,	40	72·4	31·5	2·30
Zirkon ,, ...	220 ,,	70	80·4	35·7	2·25
Hopfelt ,, ...	110 ,,	16			2·14
Nernst ,, ...					
(1) Frosted Globe ...	110 ,,	32			2·26
(2) Opal ,, ...	110 ,,	32			2·19

In the case of the other lamps mentioned the following results were obtained :—

Petroleum Lamp (old type of burner).—1. With Russian oil	1·82
2. With American oil	1·88
3. With Oxygen fed into the flame	2·37
Incandescent Mantle	3·2
Arc Lamp, using pure carbons (9 amps.)	3·5–3·6
Sun (sky covered with light white clouds	5·0

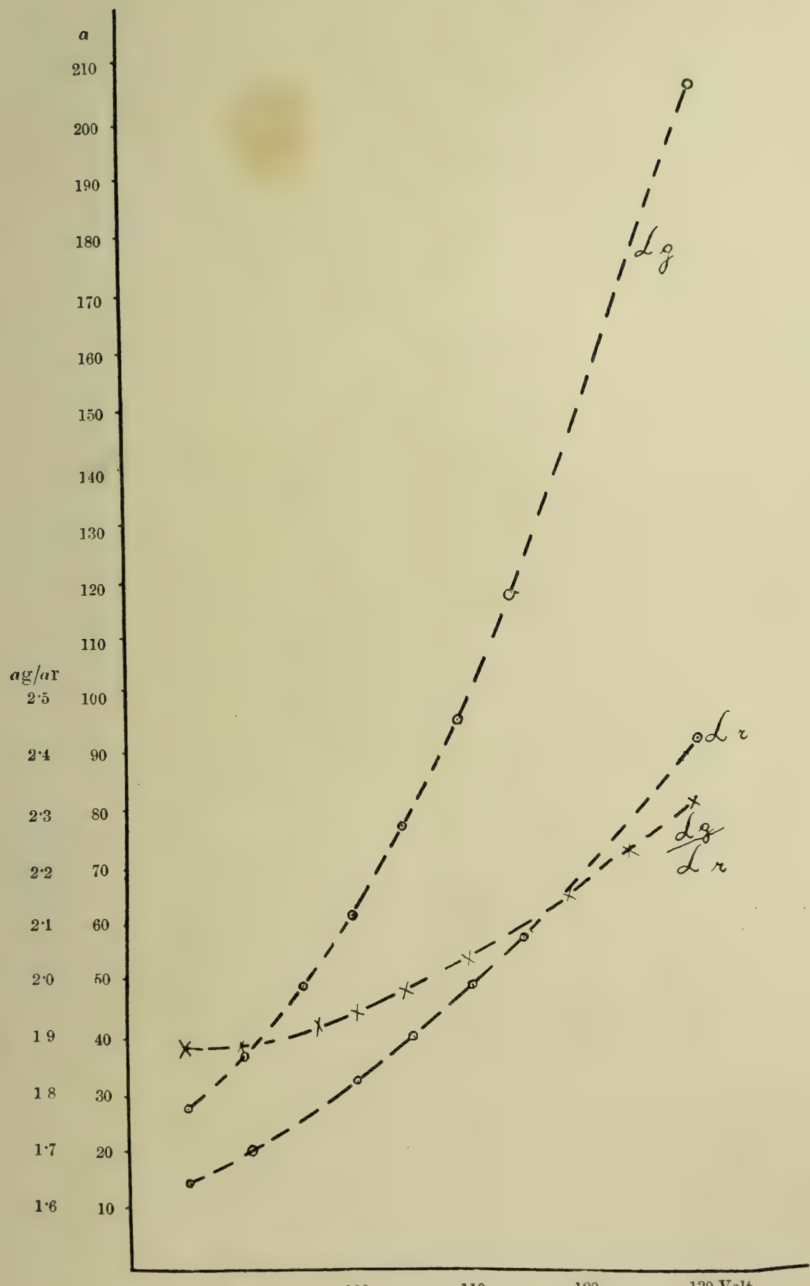


Fig. 2.

Values of ag, ar and ag/ar, for Carbon Filament Glow-Lamp run at different P D's.

It is interesting to compare the values, obtained by the application of the method of the writer, for the absolute temperature of various sources. To-day the probable temperature of the sun is generally accepted as being in the neighbourhood of 6000 degrees, while the temperature of the arc has been determined by several workers as follows :—

Lummer and Pringsheim	Pos. crater	3,750 to 4,200 deg. C.
Abney and Festing	Pos. crater	3,600 to 4,000 ,,
Violle	Pos. crater	3,900 ,,
Wilson and Gray	Pos. crater	3,600 ,,
Wanner	Pos. crater	3,700 to 3,800 ,,
Wanner	Neg. Carbon-tip,	3,000 (about) ,,

The temperature of the arc-lamp would therefore be supposed to lie between 3600 and 4200 degrees. Lummer and Pringsheim have estimated that of the incandescent glow-lamp to be in the neighbourhood of 2040 to 2100 degrees, and G. Schulze gives the value 2250 for the osmium lamp. The temperature of the incandescent mantle has also been determined by Lummer and Pringsheim, by spectrobolometric means, as 2200 to 2450 degrees, but Holborn and Kurlbaum, and also Rubens, suggest that the temperature, even of the hottest portion, is only 1800. In the following table these values are compared with the corresponding values of the factor $\frac{ag}{ar}$:—

Source	$\frac{ag}{ar}$	Temperature
Sun	5·0	6,000
Arc-lamp	3·5—3·6	3,600 to 4,200
Inct. Mantle ...	3·2	1,900 to 2,400
Osmium Lamp ...	2·29	2,250
Carbon filament lamp	2·06	2,070

The values of $\frac{ag}{ar}$ are very much what the corresponding temperatures would lead us to expect, except in the case of the incandescent mantle. (That the temperatures happen to be about 1000 times the value of $\frac{ag}{ar}$ in each case is naturally merely a coincidence).

But it must be remembered that the values of $\frac{ag}{ar}$ can only be taken as a criterion of temperature in the case of all the illuminants compared employing pure temperature radiation ; this is the case for the carbon filament lamp, and is probably mainly true of the metallic filament lamps. But it is not so in the case of the incandescent mantle. Had the light from the mantle been due purely to temperature radiation it would have been necessary to assign a temperature of about 3200, instead of about 2000, as appears actually to be the case.

Dr. Lux* by the use of the spectrophotometer, has determined the temperature of the Hopfelt lamp to be about 2155 to 2260 degrees absolute, according as the lamp is burned in its correct position so as to utilize a filament burning in an atmosphere of mercury vapour or no. The author's method gives 2·06 for ordinary carbon lamps and 2·14 in the case of the Hopfelt lamp. It will be observed that the ratios of the temperatures, $\frac{2260}{2155}=0{\cdot}95$, and of the values of $\frac{ag}{ar}=\frac{2{\cdot}06}{2{\cdot}14}=0{\cdot}96$, agree very well.

From the results described, therefore, the author considers that this simple method of procedure can very easily and conveniently be applied to the study of the radiation of ordinary sources. When it is desired to compare the result obtained by using a new form of apparatus with those obtained under the old condition, all that is necessary is to calibrate the new arrangement testing in terms of a standard lamp previously studied in the old apparatus and burning under exactly the same conditions.

For this purpose it is not advisable to use daylight, which is known to vary considerably in spectral composition under different circumstances. It is preferable to employ a carbon filament glow-lamp, running at a certain specified consumption such as 3 watts per H.K.

* *Illuminating Engineer*, 1908, p. 634.

Modern Arc-Lamps and their Applications.

By J. Rosemeyer.

Director of the Regina-Bogenlampen-Fabrik.

(*Continued from p.* 995, *December*, 1908.)

The Helia lamp is chiefly to be recommended in cases in which the cost of energy is over 20 pfennig (about 2*d.*) per kilowatt. The saving in current in the Helia lamp, as compared with the Reginula, is about 40 per cent. On the other hand the consumption of the carbons proceeds more rapidly. Under the conditions indicated, however, the cost of carbons is relatively less than the cost of energy, and the Helia lamp therefore finds useful application in the illumination of shop-windows, showrooms, &c. It is also to be recommended for inverted lighting in drawing-offices, because the small diameter carbons used is specially conducive to a steady and well-diffused system of illumination.

Reginula lamps are employed in shops, restaurants, factories, &c., in many cases in which an arc-lamp of high intensity is not necessary, especially in long and narrow rooms, for which high candle-power arc-lamps are not adapted on account of the uneven nature of their distribution of light.

Rows of vices, which were formerly illuminated by local glow-lamps, necessarily placed within the reach of the worker, and therefore easily inadvertently damaged, may preferably be replaced by small arc-lamps capable of being hung higher up out of reach. For such a purpose it is naturally essential to use lamps taking but little current, and the Reginula, which takes only 2 amperes, but nevertheless burns very quietly and steadily, is here advantageous. A single lamp taking 2 amperes and 110 volts yields about 240 candle-power, *i.e.*, about four times that attainable by glow-lamps taking the same power, and it burns for three or four times as long as an arc-lamp of the ordinary variety without recarboning. An example of the behaviour of such lamps under outdoor conditions is furnished by some 400 alternating current lamps that have burned successfully for over four years in all kinds of weather in the German colony at Tsingtau.

One distinct advantage can be attributed to methods of diffused indoor illumination with high candle-power sources. In such cases uniform illumination is very desirable. If the lighting is secured by distributing local glow-lamps about the room to meet the needs of present conditions, it becomes necessary to alter their positions whenever it is desired to alter the location of the various machines, &c., in the room. If, however, a plan of lighting is resorted to which illuminates every portion of the room satisfactorily, it will also suffice even when the positions of objects are altered.

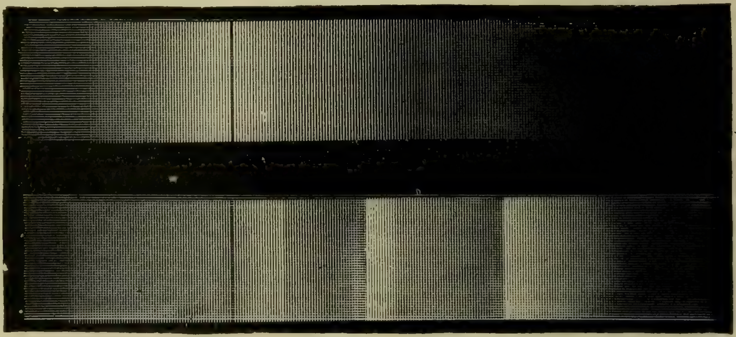
Hitherto the writer has referred to varieties of arc-lamps that are mainly intended for indoor illumination. For outdoor lighting or for the illumination of large halls, &c., provided with suitable ceiling ventilation, flame arc-lamps are desirable. Such lamps are so arranged as to permit free access of the oxygen in the air to the arc, so as to promote the process of combustion. The cores of the carbons employed contain special salts of calcium-fluoride and other "luminescing" materials by the aid of which the light from the lamps is increased. The presence of this core, however, accentuates the radiation of long wave-lengths in the light of the arc, which consequently has a yellowish character.

In these and all other varieties of arc-lamps it may be observed that no great gain in efficiency can be anticipated by varying the nature of the mechanism; the same carbons burning with the same current yield exactly the same light in lamps of very widely differing construction.

The construction of flame arc-lamps, however, presents one marked divergence from the older lamps, namely, the use of inclined carbons burned side by side, instead of those vertically one above the other. This was rendered necessary by the tendency of the volatilized chemical materials to form non-conducting slags, which, in the case of vertical carbons, would gradually encrust the tips and thus eventually interrupt the circuit.

An additional result of this method of placing the carbons is that a higher efficiency is obtained, owing to the gain in the light that would otherwise be absorbed in the lower hemisphere. On the other hand this concentration of light in a downward direction has the drawback that the greatest illumination is produced immediately below the arc itself, causing uneven distribution. As the intensity of these flame arcs exceeds 1,000 candle-power it will be understood that such concentration, giving rise to sharp contrasts in illumination, is not desirable. This quality fits them for the illumination of shop-windows, signs, &c.; but for ordinary purposes of illumination we desire rather the production of a uniform and diffused ground-illumination. In order to obtain such a uniform illumination with lamps having inclined carbons it is necessary either to use lamps of smaller candle-power, or to maintain them at an exceptionally great height. Hence we not infrequently see flame arc-lamps erected on masts of 12 to 16 metres high. This gives rise to a corresponding loss of light in accordance with the inverse square law. The result of employing a few high candle-power sources, spaced widely apart, down the centre of the road, is that not infrequently, although the lighting of the portions of the roadway immediately below the lamp is brilliant, this illumination rapidly fades away on either side until, on the pavement, it is almost indistinguishable.

Ordinary Arc-Lamp.



Regina Copying Arc-Lamp.

FIG. 7.—Spectra of Regina and Ordinary Arc-Light.

Carbone, in his well-known lamp, was among the first to utilize the principle of inclined carbons. But the lamp consumed 10 amperes at about 80 volts, *i.e.*, on an ordinary circuit over 1,000 watts, a power-consumption that had never been employed in a single lamp before. The efficiency was only half that attainable by using flame-cored carbons, and this, in conjunction with the high consumption of the single lamp, prevented its technical development. In the same way a Prima lamp, using pure carbons, consumes the same amount of power as two lamps of the kind using flame-carbons, and yet yields less than the light of either.

Recently a marked improvement has been introduced by the Regina Co.,

which enables vertical flame-carbons to be used. This result is attained by using an entirely new variety of carbon. The ordinary carbon consists of a thick carbon covering and a thin core ; the new type, on the other hand, utilizes a relatively thick core, and only a very thin and hard outer carbon coating. The lower carbon is the positive one, and this enables the deposition of slag to be avoided. The P.D. across the terminals of such lamps is about 30 volts, but it is possible to run three in series on 100 volts. The smallest type consumes 8 amperes and 293 watts, and yields a favourable distribution of light similar to that of the Regina, Reginula and Helia lamps. In the case of such lamps high posts are not necessary to secure a satisfactory distribution of ground-illumination. Moreover, the thick carbons burn longer, and are not so liable to mechanical injury.

A new flame arc-lamp of this type is the Rebofa, which yields light of a pure white colour : lamps of this type can be run three in series on a P.D. of 110 volts. The mechanism is also of a simple character.

The fumes generated by all these flame-lamps prevent their being applicable to the illumination of small enclosed rooms. In large halls, &c., where the gases generated are enabled to escape by adequate ventilation, they can be used if need be ; nevertheless, they find their chief application for the lighting of streets, open spaces, and signs.

Modern arc-lamps are also of value for purposes other than illumination, and have, in many cases, caused a revolution in existing technical processes. This is particularly true of copying and photographic works, &c., which now utilize the chemical action of the rays from the arc-lamp. A notable example of this is in the making of blue prints of tracings. Every one is aware how tedious the process of making such prints is in the winter, when the light is poor. It is, therefore, a great advantage to be independent of capricious daylight, and to utilize an effective artificial illumination for this purpose. In Fig. 7 is shown a photograph of the spectrum of the Regina copying lamp, exhibiting the richness of the chemically useful rays in this lamp.

By the aid of an arc-lamp, consuming 220 volts and 8 amperes, it is possible to make ordinary blue prints within two minutes each, at a cost of only 15 pfg. per hour. The cost of the illumination per print is thus only about $\frac{1}{2}$ pfg.

More recently an automatic copying machine has been put upon the market. An example of such a machine is shown in Fig. 8.

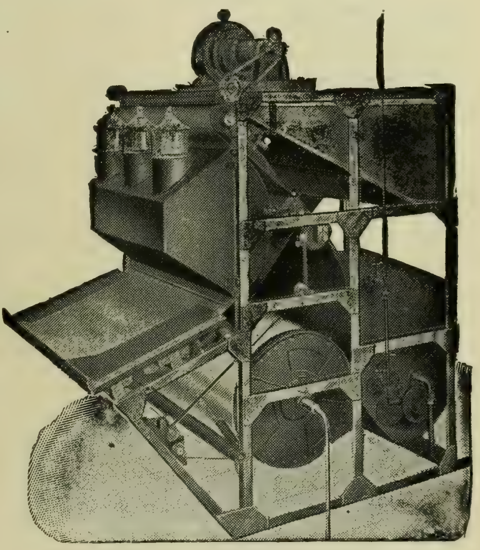


FIG. 8.—Automatic Copying Apparatus.

In this machine the tracing to be copied is superimposed over the sensitive paper, and automatically presented to the source of light. Subsequently the original is peeled off, drawn through a water-bath, and finally passed over a heated drum, on which it is dried. After leaving the drum the endless band of paper is wound on to a roller and cut into pieces as required. Thus the whole action of exposure, washing, hanging, drying, and cutting up is executed automatically and with the utmost precision. Such an apparatus, constructed by the firm of J. Pohling of Cologne, passes through paper at the rate of 40 to 70 metres per hour, and is capable of making 400 to 700 blue prints in a day.

Photographers, who were formerly obliged to build glass erections on the roofs of buildings in big towns, may to-day have their studios on the ground floor, for they can utilize artificial light and achieve better results than would be obtainable by using the most perfect daylight conditions.

Since the achievements of Finsen in the domain of light-therapeutics the arc-lamp has played an important rôle in medical science. Incandescent lamp-baths have been extensively replaced by arc-light arrangements, the rays of which are more effective in stimulating the skin. For instance, in the Sanatorium Weisser Hirsch in Dresden there is a large bath of this description, the light for which is furnished by 100 Regina arc-lamps; these play upon the bodies of those who recline on the beds, and replace the uncertain action of sunlight. A type of lamp for therapeutic work is shown in Fig. 10.

And, lastly, attention may be drawn to the value of good illumination in a large works, which use, say, 100 arc-lamps, costing in upkeep, perhaps, 3,000 marks during a year. One should consider how small this sum appears in comparison with the other inevitable running costs of a large concern, and how surprising it is that so small store is often set upon the value of good artificial illumination.

When provision is not made for the eyes of workers good work cannot be expected of them. We must secure, both for the work-tables and the materials used, good illumination; only when the lighting is faultless can we judge quality of work justly. The new director of a certain well-known but formerly unprosperous concern, who desired to economize, nevertheless desired as the first requisite a good system of illumination, in order to accelerate and improve the quality of work turned out. He decided to

Fig. 9.—Arc-Lamps for Photographic Copying.

replace the existing illumination by means of distributed glow-lamps by a modern system of arc-lighting. The experiment was tried first in one room; in another year all the other departments had followed suit. To-day the business is eminently successful.

The restless activity of the present day demands the continual improvement of artificial illuminants; without the progress in modern methods of illumination we should have been unable to utilize the hours of darkness and live our modern commercial life. Thanks to these improvements, we can hope to attain conditions of artificial illumination which rival the conditions characteristic of daylight. Apart from the necessity for good illumination in order to secure better work, good lighting is also desirable from the hygienic aspect—in the interest of the eyes of those using it. Modern strenuous competition often compels the consideration of new processes and the erection of new premises in order to secure increased rate of production, and this in turn demands the improvement of a method of illumination that might hitherto have been deemed adequate; but it is doubly satisfactory to realize that it is also possible to secure improved hygienic conditions at the same time.

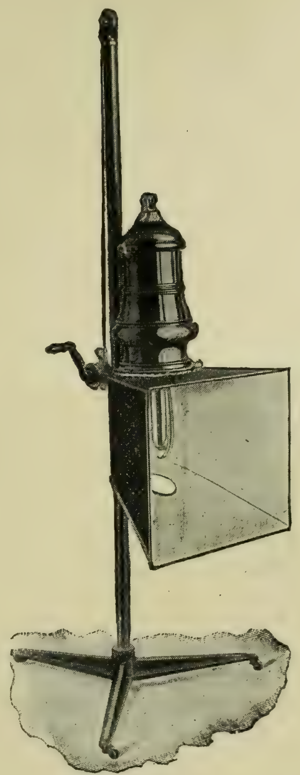


FIG. 10.
Enclosed Arc-Lamp for Therapeutic Work.

The Lighting of Machine-Shops by Flame-Arcs.

A WRITER in a recent number of *The Illuminating Engineer* of New York makes a very pertinent comment on the necessity for conditions of illumination being now as perfect as possible in machine-shops, if only on account of the far greater accuracy in work now demanded.

There is, perhaps, no other branch of industry that has undergone such a revolution. Not so long ago, shops in which heavy work was done were often semi-dungeons, in which workmen groped their way about by the feeble light of smoking torches. Naturally the order of accuracy demanded in those days would be considered ridiculous now.

But our present achievements in this respect, and our tendency towards yet greater perfection, is only possible when a thoroughly good illumination, enabling each worker to see every detail of the job on which he is engaged, is available.

In modern buildings, in which much heavy crane work is usually installed, a high ceiling is a necessity: these conditions are well adapted to the flame arc-lamp, with its concentrated downward illumination. A few such lamps, slung among the roof-trusses, may form the basis of what seems an economical and satisfactory method of getting the required diffused and shadowless illumination.

The Production and Utilization of Light.

The Laws and Measurement of Radiation.

By Dr. C. V. Drysdale.

(*Continued from p.* 900, Vol. I.)

Work of Langley.—These researches were repeated on a much more accurate scale by Langley with his bolometer in 1881. He obtained the curves of distribution of radiation for a flame, an arc, the sun, and for the light from a firefly, as in Figs. 2–5. In the case of the sun the position of maximum intensity of radiation was well inside the visible spectrum, being in the yellow green; while in the case of the firefly* he found that the *whole* of the radiation appeared to be confined within the limits of the visible spectrum, between wave-lengths ·45 to ·65μ, and consequently that its light was practically of perfect efficiency. This is an extremely important point, as it shows that there is no natural barrier to the obtaining of a high luminous efficiency.

Draper's Law.—In 1847 Draper found that at a temperature of 525 degrees Centigrade various bodies commenced to give visible light in the form of a red glow, and he assumed that the temperature at which bodies commenced to be visible was the same, whatever their nature. Weber and Emden† in 1887, however, found that gold commenced to glow at 423 degrees Centigrade, and German silver at 403 degrees, and further that the first glow, instead of being red, was of a greyish colour.

This has since been explained on the theory that we have two distinct kinds of perception, that of light which is due to the rods in the retina, and that of cones which perceive colour, but are relatively insensitive. The first glow is of such low intensity as to stimulate the rods only, and it cannot be seen if a small object is looked at directly, as the forea, or most acute portion of the eye only contains cones.

* On the cheapest form of light, S. P. Langley and F. W. Very, Phil. Mag. Vol. XXX., p. 260, 1880.

† See *Engineering*, vol. lxxvi., 1903, p. 686.

Kirchhoff's Law.—The equality of the radiating and absorbing powers of a body was given a wide extension by Kirchhoff in 1858. Starting from Frauenhofer's discovery of the dark lines in the solar spectrum, corresponding to the bright lines found in the spectrum of a glowing gas, he was led to the conclusion that any body, at any temperature absorbs exactly the same kind of radiation as it emits. This is expressed by saying that if a body emits a quantity of radiation E at a temperature T_1 between any limits of wave-length, while it absorbs a quantity A from an enclosure at temperature T_2, then $\frac{E}{A}$ is the same for all bodies. Since E=A in the case of a black body when $T_1=T_2$, the emission is equal to the absorption in every respect when the body is in an enclosure at its own temperature. The importance of this law, which is also a consequence of the second law of thermodynamics, is very considerable from the practical point of view, as it enables us at once to form an idea of the probable radiating properties of a substance. For example, if a body is transparent to light, *i.e.*, a bad absorber of luminous radiation, it must also be a bad radiator of light, unless it loses its transparency when heated. A substance which is white, or which has a metallic lustre, must also be a bad radiator of light. This should apparently condemn metallic filaments, but the explanation of their efficiency is that they *are* bad radiators of light; but that as metallic reflection is almost uniform for all wave-lengths, they are equally bad radiators of non-luminous radiation. The proportion of luminous to total radiation is, therefore, not very different from that for a black body, and their bad radiating properties only necessitate a larger radiating surface

for a given amount of light. Metals, however, are not suitable for gas-mantles, where the heat is supplied from an external flame, as their bad absorbing and radiating powers make them take up and emit very little of its energy. It is clear that the ideal substance to be employed for incandescent electric lighting is one which is perfectly black when seen by ordinary light, but perfectly transparent or perfectly reflecting to all radiation outside the spectrum.

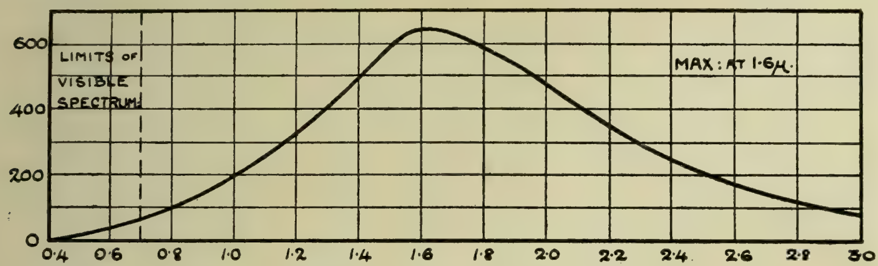


Fig. 2.—Energy distribution in Flame Spectrum.

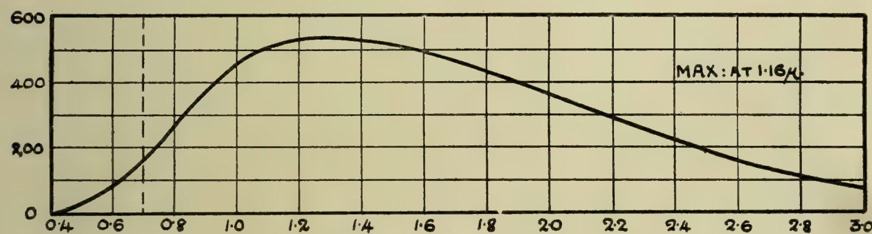


Fig. 3.—Energy distribution in Arc Spectrum.

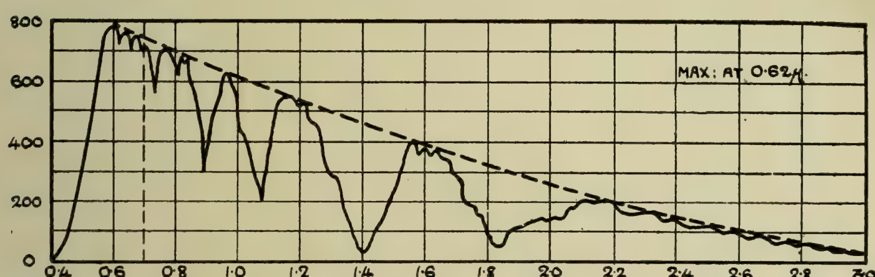


Fig. 4.—Energy distribution in Solar Spectrum.

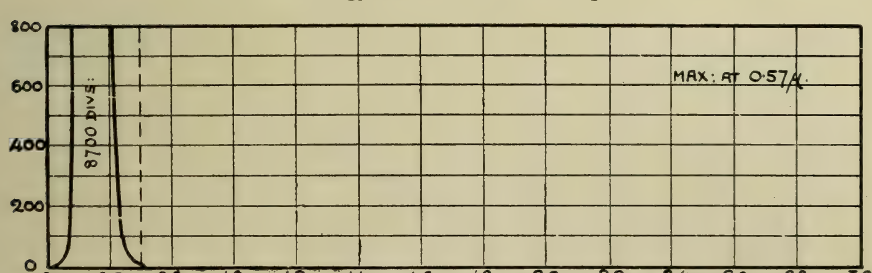


Fig. 5.—Energy distribution in Firefly Spectrum.

Langley's Curves of Radiation.

(To be continued.)

Diagnosis under Artificial Light.

An interesting point from the standpoint of physicians was raised by Mr. A. Cressy Morrison in a recent paper delivered at the Eleventh Annual Convention of the International Acetylene Association, held in Chicago this year.

Our conceptions of the correct appearance of the skin, &c., he points out, are mainly formed by reference to daylight; naturally, therefore, the judgment of a physician is liable to be disturbed by the distortion of such effects under artificial light, which may cause colours to appear very differently from when observed under daylight conditions.

For instance, Mr. Morrison suggests, a tissue examined under a flame gaslight, containing a strong red element, tends to appear unduly red and inflamed; on the other hand, the absence of red and the preponderance of green makes red-coloured surfaces appear relatively dark in hue and, in an extreme form, may produce a positively ghastly appearance. Indeed, people's faces, viewed under many mercury lamps, appear sea-green and their lips purple.

It can, therefore, be understood that an illuminant yielding a colour definition exactly similar to that of daylight, would be of service to the medical profession, and Mr. Cressy Morrison argues in favour of the adoption of acetylene in hospitals on this ground. However, as *The Illuminating Engineer* has pointed out, the conflicting claims, in this respect, on behalf of different illuminants, suggest that cautious scientific study is needed before any definite statement on such a point can safely be made.

Moreover, it is not so easy to predict what the exact influence of a certain illuminant on medical diagnosis is likely to be. It may be observed, for instance, that Mr. F. W. Peebles, writing in *The Illuminating Engineer* (New York), points out that, inasmuch as ruddy inflammation is made evident by *contrast* with the surrounding whiter skin, the effect of accentuating red rays in the illuminant would be to cause the contrast in colour to appear *less* marked, and hence to suggest that the inflammation is less severe than it actually is.

On the other hand, he states, greenish illuminants, poor in red rays, for the same reason, tend to accentuate such a contrast.

In this last connexion it is interesting to recall that a certain value has been attached to the mercury lamp as an assistance in diagnosis, for this very reason. As the lamp contains practically no red rays, its light is stated to enable an incipient "rash" on the skin to be detected at an earlier stage than would be possible by ordinary light.

All these are points on which the evidence of the medical profession is needed, and this question of the colour of artificial illuminants may be commended to their attention.

Daylight Illumination in the House of Commons.

Mr. F. W. Verney, M.P., has been complaining of the inadequate arrangements at present existing for the admission of sunlight into the House of Commons. Although the general arrangements for ventilation are admitted to be good, the provision for the admission of sunlight is not.

No system of ventilation (he says) can be anything but a failure if sunlight is left out of it, and this is what has happened in the case of the House of Commons. The House was constructed with an almost entire disregard of sunlight. It is seldom that a ray of sunlight ever gets into it. Mr. Verney wants sunlight admitted, "not through chinks or sidelights for an hour or two in a summer's afternoon, but streaming in through big windows with clear glass—so that, open or shut, the sunrays shall come in."—*The Westminster Gazette.*

The German Tax on Gas and Electricity.

By Our Berlin Correspondent.

The proposed tax in Germany on gas and electricity, and also on sources of light, including incandescent mantles, electric glow-lamps and arc-lamps, has given rise to keen dislike and opposition on the part of consumer and producer alike.

Every one must admit that the scientific and industrial progress of all countries, and perhaps pre-eminently of Germany, is in the highest degree to be attributed to the industry of its inhabitants. In the Middle Ages, when the activity of man ended with the setting of the sun, science and industry may be said to have remained in a relatively stagnant condition. When first mankind learnt to turn night into day by the aid of cheap and hygienically correct sources of light, free from the inconveniences and disadvantages to health which characterized the earlier pitch-torches, fat-lamps, &c., scientific and industrial processes underwent a rapid development.

Since that time the different methods of artificial lighting have steadily competed with each other in the directions of cheapness and efficiency, and now this use of light, on which rests the possibility of work after sunset, is to be subjected to a severe setback.

During the last twenty years gas and electricity have come to be regarded not as luxuries but as necessities ; but a very small proportion of the flames burning after nightfall can be said to be utilized as a luxury. The great majority serve to facilitate strenuous work, or to promote those modest comforts in life that prepare the worker for the toil of the next day.

Gas, in particular, is used even by the poorest man for cooking or illumination at the present day. So well is this recognized, that many gasworks instal piping, lights, and meters gratis, and gas for heating or cooking may be secured by payment of a 10-pfennig piece in the slot-meter. The working woman, who returns tired out to her home after the day, can have her cooking range in operation by merely turning on a gascock.

It is suggested, however, that installations that consume less than $1\frac{1}{2}$ cubic metres of gas or $1\frac{1}{2}$ units of electricity per hour, shall be freed from the tax. This means that science will be taxed, for to-day there are many technical institutions, schools, and even private investigators, carrying on valuable research work necessitating the consumption of far higher quantities of gas or electricity than the above. In this age of high currents and energy consumption this is particularly true, for the experimental work of this generation can no longer be carried out by the aid of a few primary batteries, &c. Thus people who spend time and money in scientific experiments, often without expecting any reward except the recognition of their value, will also be subjected to the tax.

Gas and electricity to-day play an important part in all callings, and all unite in protesting against the proposed imposition. The big industries object because gas and electricity are needed to drive their machinery or to light their workshops. The small manufacturer protests because it is only through the cheapening of the cost of electricity that the application of electric motors became possible to him. Mines are likewise prejudiced by any restriction on the use of the electricity that has become so vital a necessity. Those towns who have undertaken municipal gas and electrical supply also naturally dislike the tax, and there is a well-grounded objection among medical institutions that now frequently employ electricity for therapeutics to a considerable extent. And, lastly, even the agricultural population is opposed to the tax. At one time petroleum lamps were extensively used for illumination in country districts. But to-day agriculture has also become

industrial, and the scarcity of labour and other causes in different parts of Germany have led to the extensive adoption of electrical machinery.

As regards the individual instances of the application of the tax, many cases of injustice can be pointed out. Each incandescent mantle is to be taxed to the extent of 10 pfennigs. But it is well known that mantles are very frequently broken by inexperienced hands while being placed in position on the burners, and thus people pay the tax without receiving even one-tenth of a candle-power in return. This is particularly true of portable petroleum or alcohol incandescent lamps, which are moved to and fro. The taxes on electric glow-lamps are rated as follows :—

(1)	0 to 15 watt	...	5 pfennigs each.
(2)	15 ,, 25 ,,	...	10 ,, ,,
(3)	25 ,, 60 ,,	...	20 ,, ,,
(4)	60 ,, 100 ,,	...	30 ,, ,,
(5)	100 watt upwards	...	50 ,, ,,

A carbon filament incandescent lamp, yielding 16 H.K., consumes about 48 watts, falls under the heading (3), and is taxed 20 pfennigs. The cost of renewal of such lamps is to-day about 20 pfennigs, and their original cost about 30 pfennigs. The effect of the tax is, therefore, to increase the cost of the lamp 80 to 100 per cent.

A metallic filament lamp, on the other hand, consumes, say, about 50 watts and yields 50 H.K., and thus also is subjected to a tax of 20 pfennigs. But the initial cost of such a lamp amounts to 3 marks, and therefore the effect of the tax is only to increase this by 7 per cent. Installations in which the constant vibration to which they are subjected prevents the adoption of metallic filament lamps, would therefore now have all the more reason to regret that this is the case.

It may also be noted that arc-lamps are free, but carbons are taxed at the rate of 1 mark per kilogram. In addition mercury-vapour lamps of 100 watts consumption are taxed 1 mark.

The tax on carbons would increase their cost, in the case of open arc-lamps, by about 100 per cent, and would be felt most severely in the case of flame arc-lamps. This would tend to assist the retention of enclosed arc-lamps which are economical in carbon-consumption, but in danger of being ousted by flame-arcs.

Some attention has been bestowed on the tax on gas and electricity for heating and lighting in Italy. The Italian tax is, however, confined to the gas or electricity, and is not imposed on *actual illuminating apparatus*. Moreover this tax was applied in Italy at a time when gas and electricity did not play the important rôle in industrial processes that it does now, and were indeed mainly a privilege for the rich.

As an illustration of the class of consumers who utilize gas, we may take the following figures relating to an average German town :—

Monthly Consumption of Gas in Marks.	Number of Consumers.	Percentage of Consumers.
Marks 0 to 2	22,906	19·2
,, 2 ,, 4	28,827	24·2
,, 4 ,, 6	21,516	18·1
,, 6 ,, 8	14,317	12·1
		73·6
,, 8 ,, 12	14,449	12 1
,, 12 ,, 17	7,410	6·2
,, 17 ,, 25	5,204	4·4
,, 25 ,, 33	1,683	1·4
,, 33 upwards	2,688	2·3
	119,000	

These figures show that gas is, to-day, literally a necessity for the great bulk of the population, just in the same way as air or water.

An additional argument against the proposed tax is that the administration would be extremely difficult. It can hardly be undertaken by cheaply paid officials, and would demand the service of men with technical knowledge, and therefore correspondingly dear to employ. It has been estimated that the greater portion of the revenue derived from such a tax would be devoted to maintaining a competent staff of officials, if the State desired to supervise it in an adequate manner.

In connexion with this article attention may be drawn to the protest on the subject of the proposed tax, addressed to the Reichstag by the Verein Deutscher Ingenieure: Herr G. Dettmar, the General Secretary of the Verein, communicates a copy of this letter to the *E. T. Z.*, December 3, 1908.

A Study on the Economical Possibilities of Lighting by Means of Carbon Filament Lamps.

By An Engineering Correspondent.

Consumers of electricity for lighting purposes are now confronted with a multiplicity of lamps of various types, properties, and candle-power, from which to make a selection. The difficulty of judgment, to non-technical users, is increased, owing to varying properties of the different types of lamps, necessitating their use on suitable circuits of high or low voltage, on direct or alternating current. Although great advancement has been made by the improved forms of electric glow-lamps, the carbon filament lamp continues to be the most widely employed, and will probably be in favour for some time, owing to its adaptability to all conditions of supply, and requirements as to candle-power, and also to its low price, and reduced liability of breakage during transport. Furthermore, it is possible where the price of current is high, to reduce the lighting cost, by using lamps of higher efficiency.

	100 Volts.		200 Volts.	
	C.C.	A.C.	C.C.	A.C.
Bastian Mercury Vapour Lamp	120	—	120	—
Carbon Filament ...	$2\frac{1}{2}$	$2\frac{1}{2}$	5	5
Nernst	30	30	30	30
Tantalum	16	16	32	32
Tungsten...	25	25	50	50

The above figures indicate, for modern types of electric glow-lamps, the minimum candle-power obtainable, on high or low voltage circuits.

The Bastian lamp does not burn on alternating current circuits, and the Tantalum lamp has been observed to give better results as regards useful life on continuous current circuits, although of late much improvement has been effected in the manufacture of this lamp, enabling it to be used with considerable success on alternating current circuits. Nernst lamps are reputed by some authorities to give better results on alternating current circuits than on continuous current circuits. Although there are no tests to substantiate this statement, it is known that the useful life of burners is effected by the frequency, a longer life being obtained on circuits of high frequency.

From some of the preceding data the advantages of the carbon filament lamp, in certain capacities, are obvious, in some cases it being the only lamp to fulfil certain requirements, such as low candle-power on high voltage circuits, and also for cheap replacement, where frequent breakages are inevitable. The figures relating to life and efficiency, for various sizes and voltages of carbon lamps, differ widely, perhaps the more constant of the two values being the figure for life.

This, in all lamps of ordinary efficiency, is generally accepted as being in the neighbourhood of 1,000 hours: this figure referring to the total life, as the useful life is usually much lower when calculated on the basis of 20 per cent drop in candle-power from the initial candle-power. The figures given below show the variation in efficiency of lamps of different voltage and candle-power, each lamp having an approximate total life of 1,000 hours. The expression, total life must not be confused with the useful life, as there is often a large difference in the two values.

Candle power.	100 Volt.	200 Volt.
5	4·0 watts per candle	5·0 watts per candle
8	3·75 ,, ,,	4·5 ,, ,,
16	3·5 ,, ,,	4·0 ,, ,,

These figures show a wide variation in the rating of watts per candle for

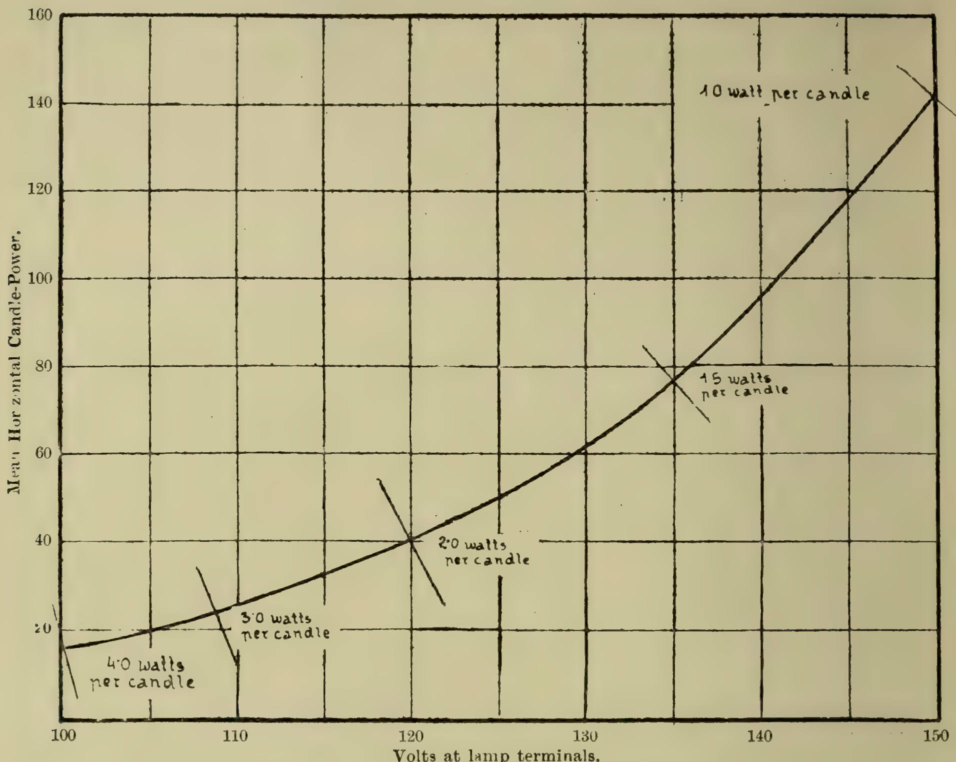


FIG. 1.—Test on a 100-volt 16 c.-p. 4·0 Watt lamp.
Curve showing alteration in candle-power and efficiency due to increase of voltage.

different classes of lamps, in order to obtain a fairly standard value of total life for all lamps. At the present day the "total life" of a carbon filament lamp is seldom taken into consideration when judging the qualities of a lamp, the period of time being reckoned as "useful life" during which the lamp loses 20 per cent of its original candle-power, therefore in this article only "useful life" is considered, calculated on the basis of 20 per cent drop from initial candle-power. It has been thought desirable to express all glow-lamp efficiencies in "watts per candle," although contrary to the opinion of some engineers, who prefer the more exact term of "candles per watt." The term "watts per candle," however, is especially useful in making lighting cost calculations, as the large unit of 1 kilo.candle-hour, or 1,000 candle hours, is usually employed, thus enabling the energy costs per K.C.H. to be determined simply by multiplying the aver-

TABLE I.

Comparative tests on 100 volt and 200 volt 16 candle power lamps run at the same average watts per candle.

Hours.	100 Volt Lamp.		200 Volt Lamp.	
	Candle power.	Watts per candle.	Candle power.	Watts per candle.
0	15·3	4·1	15·9	3·86
50	16·0	3·86	17·6	3·54
100	15 9	3·89	16·0	3·86
150	15·5	3·97	15·2	4·06
200	15·2	4·04	14·7	4·18
250	15·0	4·1	14·3	4·29
300	14·8	4·15	13·9	4·38
350	14·6	4·2	13·4	4·51
400	14·6	4·2	12·7	4·73
450	14 6	4·2	—	—
500	14·6	4·2	—	—
550	14·4	4·26	—	—
600	14·0	4·28	—	—
650	13·6	4·4	—	—
700	13·0	4·6	—	—
750	12·3	4·75	—	—
Average	14·6	4·2	14·9	4·16

age watts per candle by the price of current in pence per unit. In order to illustrate the variable qualities of high and low voltage incandescent glow-lamp, some tests are given in Table I., showing life tests on two 16 candle-power 100 volt and 200 volt lamps. Both lamps were burned at approximately the same average efficiency till a reduction of 20 per cent from the initial candle-power was reached.

The 100 volt lamp reached 750 hours at an average efficiency of 4·2 watts per candle, while the 200 volt lamp only attained 400 hours useful life at an average efficiency of 4·16 watts per candle, thus allowing nearly twice the useful life for the 100 volt lamp. In Table II., as an alternative, two 16 candle-power lamps were run under certain conditions to obtain the same useful life, which, in each case, was 800 hours. The average efficiency for the 100 volt lamp during useful life was 4·34 watts per candle, and for the 200 volt lamp 4·9 watts per candle, resulting in an energy saving of some 12 per cent for the 100 volt lamp. Although it is the universal practice among lamp-makers to rate their 200 volt 16 candle-power lamps at one-half watt per candle greater than

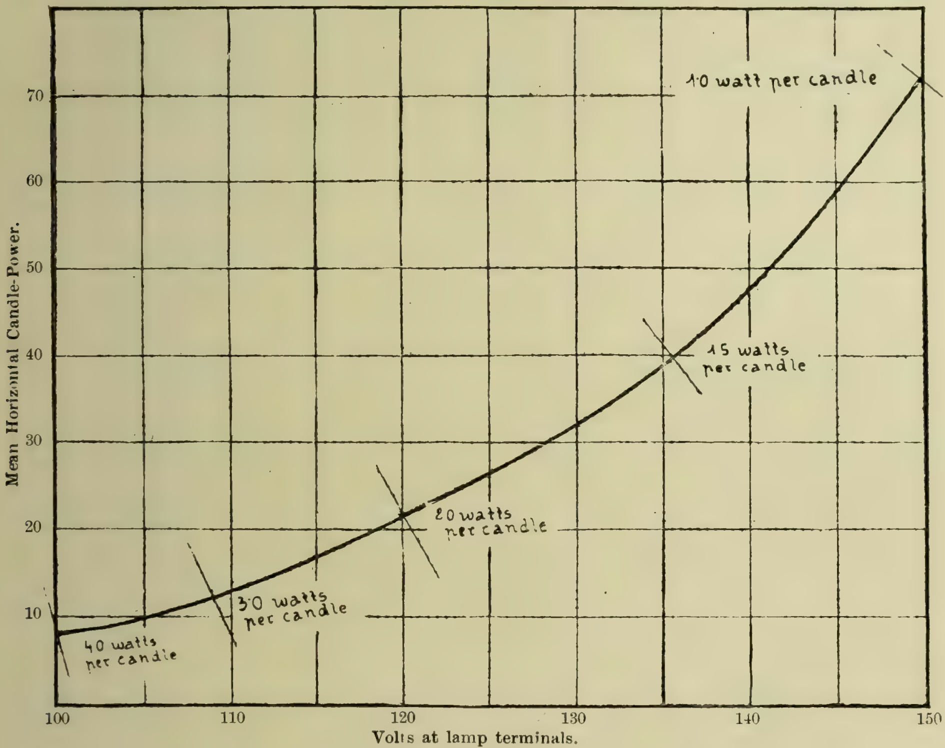


FIG. 2.—Test on a 100 volt. 8 c.-p. 3½ Watt lamp.
Curve showing alteration in candle-power and efficiency due to increase of voltage.

TABLE II.

Comparative tests on 100 volt and 200 volt 16 candle power lamps, each having the same useful life.

Hours.	100 Volt Lamp.		200 Volt Lamp.	
	Candle power.	Watts per candle.	Candle per candle.	Watts per candle.
0	15·9	3·95	16·1	4·45
50	16·5	3·9	16·7	4·35
100	16·3	3·94	15·9	4·49
200	15·3	4·15	15·6	4·53
300	14·7	4·29	15·1	4·7
400	14·3	4·4	14·6	4·83
500	13·9	4·5	14·2	4·95
600	13·7	4·6	13·3	5·30
700	13·1	4·8	13·0	5·40
800	12·8	4·9	12·9	5·50
Average	14·6	4·34	14·7	4·9

the 100 volt lamps, in order to obtain an equal number of hours' life, yet in many cases it would be cheaper to burn lamps of the higher efficiency, the saving in current offsetting the increased expenditure on lamps.

The writer has carried out an investigation on some carbon filament glow-lamps with a view to establishing some direct connexion between the "useful life" and "efficiency." To cover the whole of the field at present occupied by carbon glow-lamps would be somewhat too large an undertaking, and therefore the writer has confined his attention to a study of the lamps in most general use, these being of 16 candle-power for 100 and 200 volt circuits. Although the normal rating of a carbon lamp is about 4 watts per candle, it is possible to obtain an efficiency of 1 watt per candle by increasing the voltage at the lamp terminals; the candle-power then being many times higher than at its normal rating of 4 watts per candle. In Fig. 1 a curve is plotted from some test results on a 16 candle-power lamp, and illustrates the increase in candle-power and efficiency which takes place with increase in terminal voltage. To obtain an efficiency of 1 watt per candle the voltage must be increased to 150, and the lamp will then give about 140 candle-power. It would, of course, be impossible to overrun lamps to such an extent for practical lighting purposes, as the useful life is of exceedingly short duration, a lamp under test showing but thirty minutes, and also because of the excessive heating of the lamp and fittings which takes place. In Fig. 2, a smilar curve is shown for an 8 candle-power 4 watt lamp. The results are similar to those in Fig. 1, taking into consideration the lower candle-power limits. Both these curves are useful for determining the candle-power and efficiency of a lamp when it is required to overrun at some definite voltage, as it is not always possible to obtain lamps of any required efficiency other than of the standard ratings.

E. G. K.

(*To be continued.*)

The Wideness of the Field of Illuminating Engineering.

We have constantly pointed out how mistaken is the view, until recently held by some, that the field of illuminating engineering was too narrow to demand specialization.

There is, however, one point that any who still do not realize the scope of the work of the illuminating engineer would do well to bear in mind.

Literally, *every one* is interested in illumination. There are no varieties of work and no conditions of life that are not crippled by poor lighting, and the conditions of the age, the constantly increasing speed at which life and work are to-day carried on, and the ever extending use of artificial light only render good illumination only the more essential. In short, whatever be the source, we cannot do without light.

Invaluable as are the modern applications of electricity, the world existed without them until the last century. Gas-lighting, petrol-air, and acetylene lighting, too, ill as we could spare them, are not actually necessary to life. But light from *some* source we must have, and, while the development of modern illuminants is a special and additional argument in favour of the expert in illumination, the extent of his province is already marked out for him by the inevitably wide use of light in general.

Quite apart from the necessity of studying these questions, imposed upon us by the technical aspects of the generation and measurement of light, the mere fact that light is so generally used calls for supervision and for some decision upon certain simple standard conditions which are to be regarded as essential, and with which adequate lighting ought to conform.

Annual Convention of the Commercial Gas Association.

THE annual convention of this society was held in Chicago on Dec. 8th, 9th, and 10th, 1908. An exhibition of gas appliances was one of the features of the meeting, in which the American Gas Institute also took part.

The following is the list on some of the papers presented :—

'Selling Gas during Depression.'
Frank A. Willard, Rochester, N.Y.

'Advertising of a Public Service Corporation.'
E. St. Elmo Lewis, Detroit, Mich.

'Industrial Fuel-Gas and Special Appliances.'
S. Tully Wilson, Denver, Colo.

'Exhibition of Appliances a Necessity in Purchasing.'
Henry L. Doherty, New York City.

'Complaint and Application Departments with New Business Departments.'
A. von Dachanhausen, Butte, Mont.

'Records for a Commercial Department.'
Charles M. Cohn, Baltimore, Md.

'The Consumer.'
C. Willing Hare, Philadelphia, Pa.

'Methods of Increasing Gas Sales in a Small Town.'
Glen R. Trumbull, Lebanon, Pa.

'Demonstration Work.'
Mrs. Helen Armstrong, Chicago, Ill.

'Compiled Record of New Business Methods."
George Williams, New York.

Through the courtesy of Mr. George Williams, Mr. Geo. Thomson, Mr. C. W. Hare, and Mr. C. M. Cohen, we have received advance copies of some of the interesting papers presented, to which we make brief reference.

At the present time, when the old relations beween consumer and supply company are undergoing modification and improvement in this country, these practical papers should be of special interest.

The Consumer.

(Paper read by C. W Hare before The National Commercial Gas Association in Chicago, December 8th. Slightly abbreviated.)

THE importance of having satisfied consumers in the territory served by a gas company cannot be over-estimated, and is scarcely open to discussion; but the best means of securing this satisfaction are worthy of the constant thought of the gas fraternity.

Have we not, perhaps, been too unwilling in the past to take consumers into our confidence; and have we not, perhaps, been too willing to pass lightly over certain complaints, which, at least to the complainant, must have appeared amply justified? Absolute and painstaking frankness with the average consumer will go a long way towards overcoming his personal complaint, and will in most instances send him back to his constituents a strong advocate of the fairness and impartiality of that particular corporation.

How often has an entirely false impression of a company been established from the carelessness and incompetence of a "Complaint Clerk." In my opinion the "Complaint Desk" is one of the departments in any gas company which requires the most careful thought in the selection of its employees.

Most of our consumers who come to the office with some complaint would far rather have that complaint answered at the office, and a clear explanation given at the time, than be met with the statement that a man will be sent out to investigate, and subsequently receive a short notice stating, as in the case of a large bill, that the meter has been reread and found to have registered correctly. If the "Complaint Clerk" had taken

the time to show that consumer the amounts of his previous bills for similar periods and had questioned him closely on the uses to which gas was being put in his home, he would probably have been able to convince him of the justice of the charge, and the expense of having the meter reread or tested would have been obviated. I believe a large portion of rereads could be done away with were "Complaint Clerks" to give greater attention to each individual case, and that the expense of answering complaints could, to some extent, be lessened, were the "Complaint Clerk" possessed of sufficient technical knowledge to discuss intelligently with the consumer the cause of his trouble.

There are, however, many instances when complaints are well justified, and we should treat the consumer making these justifiable complaints as a friend, telling him frankly that he has aided us through his complaint in taking measures to prevent the recurrence of that particular complaint in the future.

There is a very pronounced opinion on the part of many gas men that the word "Complaint" is a dangerous one to be used, and that a sign with the word "Complaint" above the desk behind which your "Complaint Clerks" stand, should not be tolerated.

They reason that by making the "Complaint Desk" prominent we emphasize the fact that we have complaints, and that our service is not at all times satisfactory. They also argue that the "Order Desk" should be as far removed from the "Complaint Desk" as possible, so that prospective consumers may not gain the knowledge of the sources of complaint to which they may become heir, and that the class of consumer who complains of his large bill, solely with a view to delaying payment thereon may not be augmented. We, of course, in every community, have a certain number of consumers who spend half their time in devising ways and means to get the best of the gas company. But competent men at the "Complaint Desk" should go a long way towards lessening these evils; and a prospective consumer, hearing an intelligent explanation of alleged trouble, would be more than ever inclined to have dealings with that company.

The "Order Desk" should be separated from the "Complaint Desk" if possible, but solely for the purpose of facilitating the carrying on of the work.

A well-organized set of canvassers in the field can also be of inestimable assistance in lessening complaints, by seeing that good service is maintained, and by answering on the spot many of the minor difficulties met with by the consumer.

The service of a gas company is never at all times perfectly satisfactory, and it is quite natural that it should not be. When that time arrives it is quite probable that there will be little use for gas companies on this hemisphere. Is it not much better to take the broad ground that, strive as hard as we may, we can never become perfect, and that we receive undoubted help from our consumers in our aim to reach a stage of perfection, if they will advise us promptly and at all times, when their service is not up to the mark? Taking that ground, why should we not have our "Complaint Desk" prominently located, with a sign stating that there is where we keep a set of trained men, ready to answer the slightest wish of our customers? So long as we assume the attitude that we practically have no complaints, and that the consumer bringing one in is a most unsuual occurrence, so long are we off the road leading to the honest co-operation of every consumer with the company.

If, on the other hand, the Superintendent of the Works is constantly on the watch to see that his gas is of good candle-power, and the engineer of the Distribution Department on guard to see that the service is maintained at a high standard of efficiency; the New Business Man ever ready to see that nothing but a first-class article is sold; and last, but by no means least, the "Complaint Clerk" ever ready to give a fair answer to a question—our company will benefit

in the same proportion that the consumer is satisfied.

Being particularly interested in the new business work of a gas company, I see on all sides the pitfalls which surround the successful carrying out of that branch of the work. If our canvassers, in order to make a record, persuade a consumer to purchase an appliance for which he has really no need, or place on his premises a greater number of lights than are actually required for his work, or over-exaggerate the efficiency of an appliance you can rest assured that that consumer will find it out before long, and will commence to sow seeds of discontent, which is the very thing we wish to avoid.

And, lastly, it should not be necessary to emphasize the importance of all the departments of a gas company working loyally together. That company can consider itself lucky, indeed, which has in its employ, from the President down, a set of men whose time and thought is given to building up the goodwill of the community which they serve, forgetting themselves in the task.

Methods of increasing Gas Sales in a Small Town.

By C. R. Trumbull.

Mr. Trumbull prefaces his remarks by pointing out that the principles of organization of a gas company are very similar in both large and small towns.

The business-getter in a small town has, indeed, certain advantages. He is able to form a more intimate acquaintance with consumers, he wastes less time travelling about, and he can inspect installations and follow up complaints more easily.

Some of the best advertisements are the windows of sale-rooms. People form their conceptions of gas-supply very largely from the contents of such windows, and too great effort can scarcely be made to enable them to see gaslighting under the best advantages. One instance of enterprise in this respect was the assembling of old-style burners as a basis of comparison with modern types, the quaint old lamps bringing in many people who would otherwise have passed the window without making inquiries. Cooking demonstrations are likewise held.

Mr. Trumbull, like Mr. Hare, insists strongly on the necessity for giving full attention to the complaints of dissatisfied customers. A business man, therefore, must know his goods thoroughly, and must be able to show consumers how to use them to the best advantage.

Records of New Business Departments.

By C. M. Cohen.

This paper is devoted mainly to the organization of card-records, which enable a company not only to keep fully in touch with all prospects of new business, but to trace out the progress of any particular consumer and the condition of his installation. On the necessity for thoroughness and systematic visiting of consumers' premises in this way, great stress is laid; any grievances should be carefully listened to, and any actual defects in burners, &c., promptly remedied. Even consumers who have given no sign of discontent should receive periodical visits for the purpose of inquiring whether everything is working satisfactorily.

Into the details of the system of inspection and organization recommended by Mr. Cohen we cannot enter, but the spirit in which they are conceived is an indication of the development of a more sympathetic and broad-minded attitude of modern supply-companies towards the needs of the consumer.

"Model-Kitchens."

By Geo. W. Thompson.

Mr. Thompson pleads for the more energetic and scientific study of kitchen heating, pointing out that many people are lavish in the money they devote to dainty furnishings, "unnecessary fancy

oil-lamps that are never lighted, old hall-clocks that never run, books they never read"; but yet do not realize the importance of a cheerful and properly heated and ventilated kitchen.

Mr. Thompson's paper will doubtless provide valuable reading for those interested in the development of kitchen ranges, &c.; we hope that some time he will also present a paper dealing with the illumination of kitchens—a matter that is, at least, of equal moment in the design of a "model kitchen," and probably very intimately connected both with the health and cheerfulness of its inmates, and the nature of the cookery!

Since writing the above we have received a copy of the very exhaustive and interesting paper by Mr. F. A. Willard, of the Rochester Gas Company, on '**Selling Gas during Depression.**'

Space does not enable us to do justice to this paper in our present number, and we therefore hold it over until our next, when we propose to deal with the matter in detail.

The Association of Car-Lighting Engineers.

The first annual meeting of this newly created association held in Chicago on Nov. 16th to 20th, would seem, judging from the account of the proceedings in *The Electrical Review* of New York, to have been of considerable interest, upwards of 200 members being present.

The avowed intention of the Association is to gather together the loose threads of various branches of car-lighting engineering.

The first paper read, by Mr. P. Kennedy, was on the 'History of Car-Lighting,' the author tracing the development of the various systems now in vogue, and referring to the many amusing patents suggested in the past.

Another paper by Mr. W. L. Bliss on axle lighting, a subject which is fenced in with technical difficulties of a special nature, many of them arising from the strain and vibration to which all parts are subjected, and which renders the generation of a steady P.D. for lighting purposes a very difficult matter.

'Railway Train Lighting' was touched upon in a paper delivered in 1892 by Mr. G. H. Bauer, and read again in abstract by Mr. C. W. Bender.

Other questions connected with the lighting of trains that came up for discussion were dealt with in the report of the Committee on 'Straight Electric Lighting,' it being generally agreed that sole dependence on an electrical system, without other auxiliary apparatus than emergency candles was desirable, due attention being paid to the necessity for constant supervision and inspection.

The report of the committee on 'Head End Lighting of Passenger Trains,' discussed the three main systems in detail.

It is of interest to note that the subject of lighting proper received close attention. A report was presented by a committee who had been engaged on gathering information relating to the use of incandescent lamps on railways. There is still a field for the improvement of metallic filament lamps for use in this connexion, it being stated that it is not as yet feasible to make low candle-power tungsten lamps to run on 60 volt train circuits, on account of the fragility of the filaments. The report concluded with a number of curves, &c., furnished by the National Electric Lamp Association.

'Illumination' was dealt with by Mr. H. C. Meloy, who advocated the use of light colours in decoration of the interiors of railway cars. Mr. W. E. Ballantine also gave some particulars of the experiences of his company regarding the lighting of mail cars with Cooper Hewitt mercury vapour lamps; an interesting point referred to was the fact that the mercury tube does not operate unless a certain P.D. is impressed upon its terminals. In this way warning is given of the exhaustion of the storage cells and the danger of "sulphating" reduced.

SPECIAL SECTION.

The Internal Lighting of Churches.

By G. A. T. Middleton, A.R.I.B.A.

Probably few classes of buildings present more complex lighting problems than places of worship. This is partly due to their architectural arrangement, partly to the demands of traditional ritual, and partly to practical considerations. In England, at any rate, almost all churches belonging to either the Establishment or the Roman Catholics are Gothic, consisting of a nave with low aisles on either side, transepts and a chancel, and many of them were built at a time when any other illumination than that by means of candles was unknown. Amongst the Nonconformist bodies, on the other hand, large hall churches are quite common, while many still contain galleries, in spite of the difficulty of properly supervising them. It is not, therefore, easy to deal, except in a very general way, with the problems involved in their illumination in the course of a short article.

So far as the architectural features are concerned, it is probably best to leave them alone as much as possible. Any attempt to accentuate the lines of arches or of vaulting by means of lights will only produce theatrical effects, which will be entirely out of harmony with a building devoted to religious observances, however well they may be in keeping with the Franco-British Exhibition. This sort of thing has been occasionally attempted on the Continent and in America, particularly at festival times, with the idea of thereby enhancing the effects of Christmas or Easter decorations, but the result has generally been deplorable. On the other hand, it is not necessary to so concentrate the light for practical use as to throw none upon the architectural enrichments. Doubtless the old churches suffer nothing by this treatment. Having been designed at a time when artificial illuminants were practically unknown, they depend upon the gloom of the vaulting and the roofs to a considerable extent for their solemnity. This is sometimes the case with new churches also, and when this happens there is little need for any light to be projected upwards. There is particularly no necessity for hanging the lights very high up, the most that is needed being a slight reflection, or a little direct light such as may be allowed to filter through a moderately opaque reflecting shade.

There is a practical side also to this as well as an æsthetic one. Everybody knows how exceedingly tiring it is to the eye to be in a room which is too brilliantly and uniformly lighted, and how, on the other hand, it is quite restful to read or to write at a desk which is lighted only by a candle or a low-power oil lamp, while the remainder of the room is in darkness. This is a matter of contrast. When the general illumination of a church is low, only comparatively little light need be thrown upon the pages of the books which the congregation hold, in order for them to be read with ease and comfort; while if the general illumination is high, it must even be accentuated for reading to be easy. It will be thus recognized that the open gas flame, or the unshaded incandescent electric light, or the upright gas mantle are all exceedingly wasteful illuminants, for quite as much light is thrown upwards as downwards, and in many cases even more.

Besides this, exposed lights of any sort are extremely irritating to the

congregation, particularly those of a highly concentrated nature. The naked gas flame, even, if placed in the line of vision, irritates greatly by its unequalness and constant flickering. The gas mantle is even worse on account of its glaring brilliancy, and the incandescent wire in an electric bulb is annoying beyond description, particularly to any one who happens to be afflicted with astygmatism. All need shading in some way, and so placing that they may not too obviously intrude between the congregation and either the chancel or the preacher.

Thus it will be obvious that even the lighting of the main body of a church contains problems which are by no means easy of solution, while they vary with each case. It has sometimes been attempted to hide the lights by placing them above the abacus of the capitals. The result of doing this is to throw the light upwards and to give a diffused effect, but owing to the great height of the nave roof or vault, light thus treated disseminates, and it must be reflected downwards if the members of the congregation are to be enabled to read at all. So much light is necessary if its source be hidden in this way that few congregations could stand the constant expense.

The more usual plan is either to suspend lights from the roof, or to attach them to a standard, so placed as not to interfere with a view of either chancel or pulpit from any part of the church. In some churches existing standards can be re-utilized ; but there is always the objection to them that they cast shadows themselves. Although this could with care be overcome, it is generally better to suspend the light from the roof if possible. It is not possible to do this where there is a stone vault.

There are two methods by which the lights may be so screened as to secure the maximum of usefulness with the minimum of candle-power, and at the same time not to be too obtrusively evident to the eye of those seated behind them. Whichever of these is adopted, it is necessary to use hanging incandescent lamps or inverted mantles ; and it may be said in parenthesis that the latter can be often economically applied to a country church by the installation of a small plant for the production of oil gas. The usual thing to do with inverted lights of this type is to place semi-opaque reflecting screens above them, but these are generally brought down only a short distance, and still leave the light in view of the congregation. If, instead of this, bell-shaped reflectors are used, which come down sufficiently below the inverted mantles to screen them entirely from the view, or so far down the electric bulbs as to hide all except their lower portion, which can be of obscured glass, the actual source of light is hidden ; while a well-designed reflector of this type will distribute something like 70 per cent of the light produced exactly over the area most needing it. The lights, for instance, should not be hung quite vertically downwards, but the reflectors should be placed at such an angle as to throw light forwards over the shoulders of the members of the congregation in front rather than into the faces of those behind. The result of this will not only be to prevent glare in the eyes of the people, but to illuminate their books quite perfectly with the use of comparatively little candle-power, there being sufficient contrast between this direct light and the surrounding gloom to give that ease and rest which the eye demands.

Much the same effect could be produced on standards by adopting such a fitting as is shown in the accompanying illustration, with two or three lamps placed in a casing of ornamental metal filled in with opaque or stained glass, which with a little care could be designed to be a distinct artistic addition to a church. Of course it could also be an excessively vulgar horror, like many of the electroliers now used !

It should always be remembered in lighting the congregational portion of a church, that the illumination is not required to be equal throughout the service. There are many portions, particularly that during the delivery of the sermon, when it is better for the body of the church to be comparatively dimly lighted. Consequently the

lamps should always be in groups of say three, with controlling switches under the charge of an official who can get to his switch-board without disturbing anybody, so that at the right moment he may turn on all three of each group, or put out one or two of them as may be needed. In the case of gas, this can be accomplished by means of by-passes similarly controlled, or by a general lowering of the whole supply. It must, however, of necessity be possible to separately control each different portion of the church. One having large windows at the side, and only small ones of the clerestory type high up in the centre, will, for instance, during evening service require artificial light in the nave much sooner than in the aisles, while similarly the chancel, the organ, and the pulpit all need separate treatment.

So far as the pulpit is concerned, it is of paramount importance that the lights down the body of the church should not irritate the preacher, and this is another argument in the favour of adopting one of the systems of shading the lights which has been already advocated. It is also essential that the preacher's notes should be well lighted, preferably by lamps placed over his left shoulder. These lamps should be under his personal control by means of switches close to his hand, and they should not be so glaringly obvious to the congregation as to distract attention from him to themselves. Neither, on the other hand, should they be placed so far behind him as to throw his face in shadow. The congregation will need to see his variations of expression if they are to thoroughly understand the meaning of what he has to say. A sermon may very well be made or marred in its effect by the position of the lights around the preacher.

There are other portions of the service, particularly at festival times, when it may be desired to concentrate attention upon the chancel, and this could often be well done by hiding a row of lights behind the chancel arch. But for this, however, the lighting of the choir stalls should very nearly correspond with that of the seating, but it should be under the control of the organist, as also should his own organ lights. In contriving these it is necessary to take into consideration the possibility of their interfering with the proper reflections from his mirrors, which are always so placed that he can see the clergy when at the pulpit and the communion table, so as to take directions from them by means of signs in case of need. Some organists also have a mirror which will enable them to see how the choir boys are behaving. It is obvious that, with so

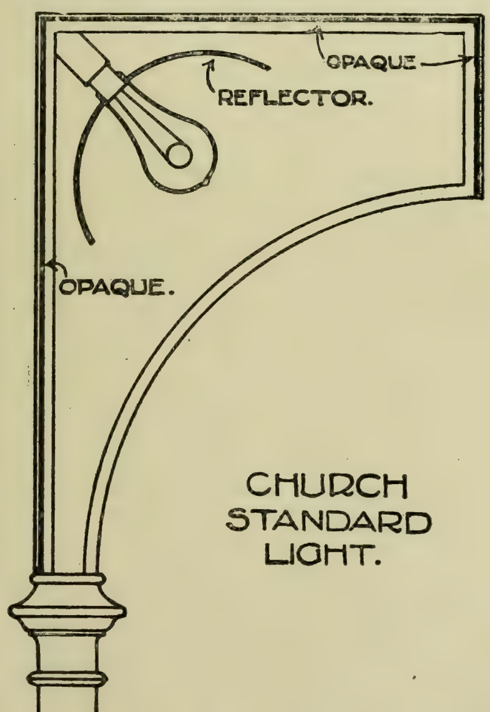


FIG. 1.

many mirrors round them, it is essential that great care should be taken in the placing of the lights.

As a matter of ritualistic tradition it is common in the Church of England, and universal in the Church of Rome, for candles to be lighted upon the communion table or altar. In olden days these were sufficient for their purpose, but now that the church is brilliantly lighted they are actually inadequate to draw attention, as was originally intended, to that portion of the church. In many cases it is

impossible to supersede them by any other light, because their use is traditional, and in some cases even enforced. The only thing to do is to enhance the effect by reflected light, the devising of which may demand a considerable amount of skill, as no two cases are alike. If it can be done without being obvious to the congregation, it is possible to throw light on to the reredos or the flowers from hidden reflectors or miniature search-lights behind the chancel arch, or close to and possibly behind the altar itself. To do this is open to the objection that theatrical means of illumination are being adapted to church purposes ; but if it be done with restraint, without extreme emphasis, but yet sufficient to bring into prominence that which is required to be most prominent, it may be the right thing to do under certain circumstances.

It will be noticed that what has been said applies mainly to Establishment churches of the ordinary Gothic type. Roman Catholic churches may require special emphasis to be given at different times to this or that particular chapel, when the placing of proper controlling switches is a matter which needs a great deal of attention, in order that the lights may be raised or lowered at the right moment by the right persons without moving from their places or otherwise disturbing the service. On the other hand, Nonconformist places of worship, particularly those with large galleries, need lighting more like theatres, and particular care has to be taken not to place the lights which illuminate the body of the building in such positions as to irritate the people who are in the galleries It is also essential that the spaces below the galleries should not be lighted by an illuminant which gives out any great amount of heat or any fumes which may be obnoxious to the people seated above. Well filled galleries have been emptied before now by thus roasting the people who have occupied them.

The Display of Church Windows.

A RATHER interesting point in connexion with the daylight illumination of churches was raised by Mr. L. W. Marsh in a recent paper on the subject before the Illuminating Engineering Society. Old churches not infrequently possess stained-glass windows of exquisite design and colouring, and yet it is often not realized that these qualities may not be properly exhibited if due attention is not given to the lighting-up of such a window by daylight conditions.

Mr. Marsh, however, describes an instance in which a fine leaded stained-glass window appeared dead and lifeless, owing to the obscuration of light by an adjacent chapel roof, limiting the incident light at an angle of 37 degrees from the vertical. Such stained-glass necessarily absorbs a great deal of light, and even plate-glass often loses 30 per cent of light by reflection at an oblique angle : good illumination was, therefore, very essential. And, in addition, even when the direct transmitted light was adequate in one direction, the illumination would probably not be so in others, with the result that the window only looks well when viewed in certain aspects.

In order to meet these difficulties recourse was had to the following arrangement. An iron frame was erected outside the window at a distance of about 15 inches from the stained-glass. In this frame were placed plates of Luxfer prisms, which changed the course of the direct light from the sky, coming from the right of the window, diffusing it horizontally and vertically in such a manner as to cause the colours and window as a whole to appear uniformly and adequately illuminated.

The "Luxfer" prisms in question consist of prisms of clear crystal glass, having a smooth outer surface and a series of accurately formed prisms inside. These prisms are specially designed to meet certain conditions ; for instance, angles were needed to obtain the desired uniform illumination.

The Illumination of Churches.

By an Engineering Correspondent.

It has been very generally remarked by those who have studied this question that the illumination of churches is a very wide subject—not only because the lights in a church may have so many varied functions to perform, but also because the very basis of what would be considered by the worshippers good illumination depends on the nature of the religious service and the tastes of those to whom it is intended to appeal. Light may be used not only for ordinary purposes, but may also form an essential part of the ceremonial of the church; certain varieties of illuminants may be selected, not for their illuminating efficiency, but for their symbolic effect and the associations connected with them.

All this naturally adds to the complexity of the task of an illuminating engineer dealing with church lighting, and in many cases he is bound to enter closely into the feeling of those who will be worshippers in the church, and modify his own plans accordingly.

At the same time many people would consider that the lighting of some of our churches leaves much to be desired, viewed from a rational and common-sense view alone. It is related that the late Rev. Hugh Price Hughes once remarked upon it as singular that places of worship were so frequently ill-lighted and gloomy, while the music-hall and gin palace never failed to provide a cheerful and attractive display! Under the circumstances it was hardly to be wondered at that many people considered the latter the more attractive!

A story with a similar moral is the joke of a well-known London entertainer who, many years ago, in his description of various places of interest, included his impressions of the interior of the cathedral at Cologne. The audience were invited to observe the view of this interior about to be thrown upon the screen, and were not a little amazed when the view turned out to be absolutely blank. The explanation assigned by the lecturer was that this accurately represented all he had been able to see on the somewhat sombre evening on which he had visited the cathedral.

Many churches and buildings of equal historic or architectural interest, it is to be feared, might be made the subject of a similar witticism. It is more than possible that many people might consider Westminster Abbey on a foggy day in this light.

The lighting of churches belonging to different denominations and religious sects naturally call for separate treatment. Dissenting chapels in general do not use light as part of the ceremonial. It may be desired to reproduce the traditional effects of church lighting in interiors of special architectural distinction, but there is no religious objection to be raised to the use of any particular illuminant. In most cases of this description, moreover, the congregation take an active part in the service, either following the lessons in the Bible or singing hymns, &c. Therefore the need for a good general illumination may be said to be greater than in the case of religious services in which the congregation are not called upon to do much reading, but chiefly watch ceremonial enacted by others or listen to the chanting of the choir.

Roman Catholic cathedrals, &c., usually fall rather under the second classification, the active part of the service being largely carried out by the priests and choristers, &c. Therefore a high general illumination would not be considered necessary, or indeed desirable, in this case, for the attitude of mind in worship of this nature is in

sympathy with a certain suggestion of mystery and the outlines of surrounding objects ought not, presumably, to be too clearly defined.

The Church of England usually offers a condition of things intermediate between these two; the congregation may take a more active part in the service, but the greater portion of the church service will be known by heart by many of those present, and it is possible that the general desire of the congregation would not be for a reading illumination throughout the entire service, but only during the singing of hymns, &c., which, of course, are read from a book. At the same time the traditional conditions of illumination in sympathy with the age and architectural features of many

FIG. 1.—The Lighting of Westminster Abbey.

such buildings must be borne in mind, and caution must be exercised in order to determine how far the most modern illuminants can be introduced without disturbing these effects. The introduction of the newer sources of light—high pressure incandescent gas, flame arc-lamps, metallic filament lamps, &c.—has presented the expert in church lighting with entirely new material to work upon. In many cases the engineer is called upon to adapt the latter to the existing fixtures in order to increase the prevalent standard of

Fig. 2.—Illumination of Holy Name Church, Manchester, by "Aegma" Metallic Filament Lamps.

illumination; it is probable that even in those instances in which a dim and subdued system of lighting has been regarded as necessary, the conventional feeling in these matters will eventually veer round to the recognition of a higher order of intensity. Meanwhile a considerable degree of taste is often required in order to apply the new to the old successfully without introducing discordant elements.

The introduction of metallic filament lamps to electrically illuminated churches in particular, calls for some care, if only because of the higher intrinsic brilliancy of such sources—so different to the dimly burning oil lamps and candles of the past.

From the point of view of efficiency pure and simple, however, the metallic filament lamps are particularly adapted to church lighting, for there is not as a rule any great demand for small units, and therefore we can use high candle power lamps, and employ the metallic filament under the most favourable conditions.

Some examples of churches so lighted are shown in Figs. 2 to 5. Fig. 2 shows a view of the Holy Name Church, Manchester, illuminated by "Aegma" lamps; Fig. 3, the lighting of St. Paul's Church, Hulme, by means of "Meridian" metallic filament lamps; for the use of these two blocks we are indebted to the Electrical Co. and the British Thomson Houston Co. respectively.

Figs. 4 and 5, again, show the method of lighting by metallic filament lamps adopted by the Siemens Schükert Co. in two churches in Germany, at Dresden and Kiel respectively. It is interesting to observe the different methods of locating the clusters of lights in these cases. In Fig. 1 centrally hung clusters are employed. In Fig. 4 the clusters are attached to standards at the ends of the pews; in Fig. 5 wall lighting is extensively utilized. While the selection of the position of such collections of lights is often subservient to that of the existing fixtures before the new method of

Fig. 3.—Illumination of St. Paul's Church, Hulme, by Meridian Metallic Filament Lamps

lighting is introduced, it is evident that the architectural features of different churches in themselves demand very different schemes of treatment; the engineer must consider whether the old arrangement, satisfactory as it may have been from the point of view

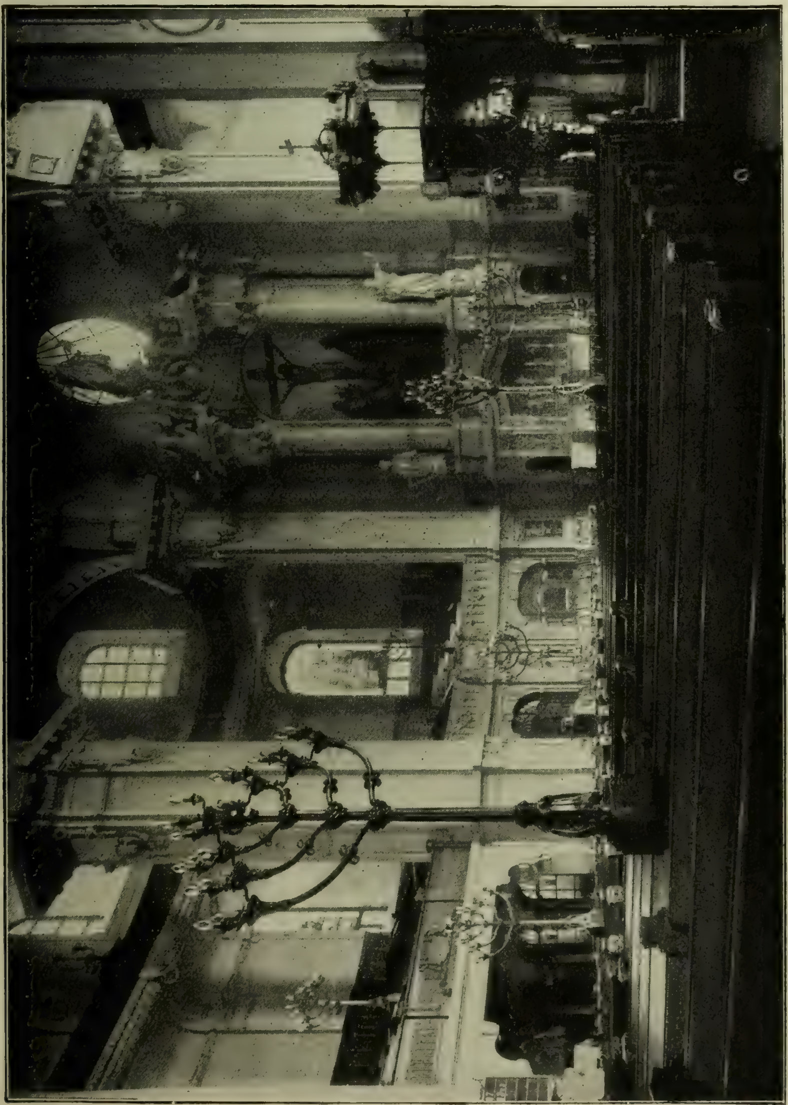


Fig. 4.—Interior of Kreuzkirche, Dresden, Germany.

of the illuminants available and the prevalent feeling, when the original fixtures were put up, is equally so in the case of modern sources of light.

At present there seems to be a need for authoritative expression of the views of the architectural profession on these points. There is a tendency, for instance, to attempt to secure the improved conditions of illumination obtainable from modern sources, and yet to imitate the relatively feeble ancient devices. For instance in Fig. 6 will be seen a bank of imitative candles consisting of small metallic filaments. This is an interesting example of the desire to reproduce ancient conditions, but one would like to hear fuller confirmation of the correctness or other-

wise of the artistic principle here involved.

In the discussion of the recent comprehensive paper by Mr. W. Basset Jones before the Illuminating Engineering Society (see the *Transactions*, January, 1908), objection was taken to the use of such admittedly imperfect imitations of the original conditions, on artistic and physiological grounds. Certainly when relatively low standards containing banks of bright metallic filament lamps are used special shading precautions would seem necessary, for it is difficult to place such units in such a way as never to come within the range of view of the congregation and dazzle them. Indeed one can call to mind churches in which such sources are allowed to come in the direct line of vision between many of the congregation and the preacher, with the result that it becomes impossible to fix attention upon his words · and in

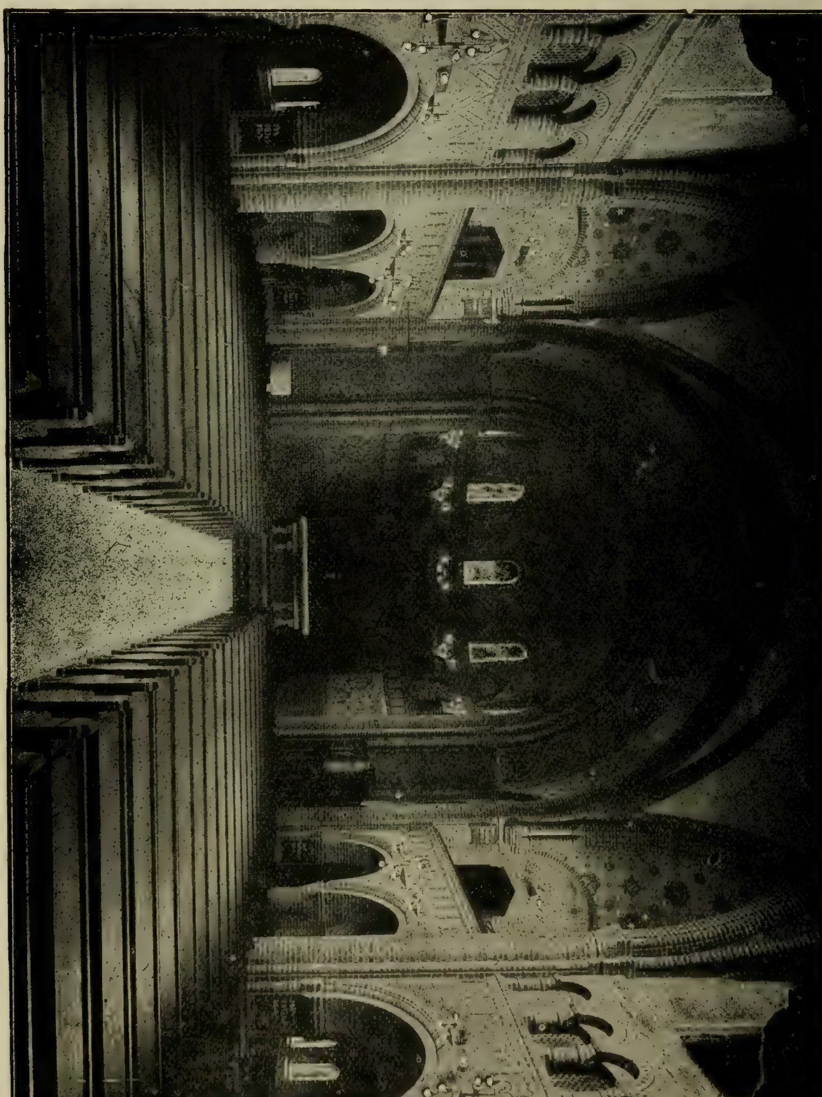


FIG. 5.—Interior of Church of St. Jürgen, Kiel, Germany.

addition gazing direct at a bright source has a distinctly soporific effect.

The same general remarks apply to the modification of the lighting of churches in which gas has been employed. The intrinsic brilliancy of the mantle, unshaded, is so great compared with the old flat flame as to occasionally necessitate care in avoiding dazzling effects of the kind referred to, and in a large building of this kind, filled with people who are looking in the same direction from many different quarters this is not always an easy matter.

In Figs. 7, 9, and 10 are shown some examples of churches illuminated by gas. Fig. 7 represents a photograph of Baddow Church, Chelmsford, illuminated by lights by the Bland Light Syndicate, with inverted units of the type shown in Fig. 8; this photograph, it is stated, was taken by the aid of the artificial light furnished by the lamps only. It will be seen that in this case it has been elected to suspend the fixtures immediately above the pews.

Lights at the sides of the church are again seen utilized in Fig. 9, illuminated by the New Inverted Incandescent Gaslight Co.

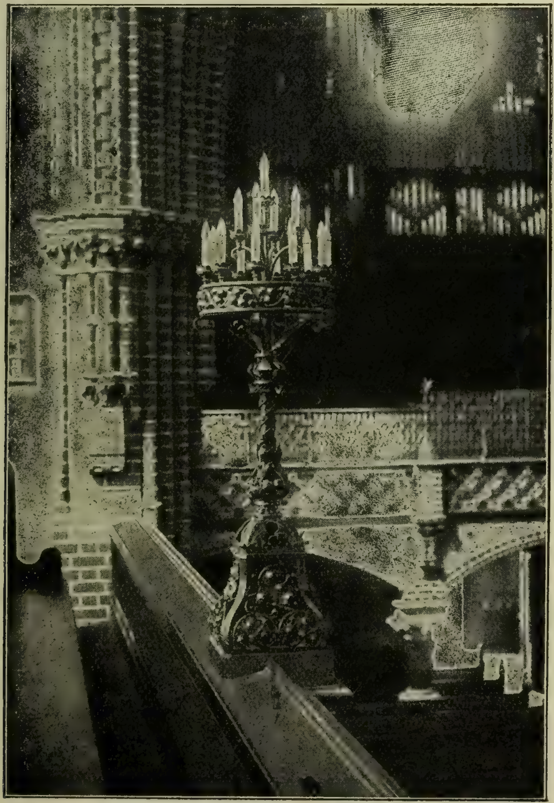


FIG. 6.—Bank of Incandescent Candles, Church of St. Jürgen, Kiel.

In the Yarmouth Parish Church, on the other hand, the method of utilizing standards situated at the ends of the pews has been adopted.

The reader may profitably compare the different methods of placing the sources displayed in these and the preceding illustrations; this alone should enable it to be seen how difficult it will often be to devise a system of illumination capable of meeting æsthetic re-

quirements, and also of filling the practical purpose of providing the requisite general illumination without ever dazzling the eyes of the congrega-

FIG. 7.—Lighting of Baddow Church, Chelmsford, by Inverted Incandescent Burners.

FIG. 8.—Type of Burner used in Baddow Church (Fig. 7).

tion or obscuring portions of the church to which their attention is directed.

One difficulty from the æsthetic standpoint, that has been referred to by Mr. W. Basset Jones, is that of finding lighting sources and fixtures on a sufficiently large scale to be proportionally correct for very huge cathedrals and churches, such as the Westminster Cathedral

The present temporary system of lighting by naked metallic filament lamps in use in the building, will no doubt subsequently be replaced by something more in keeping with its architectural pretentions.

An interesting possibility that has been suggested is that of employing groups of flame arcs and high candle-power pressure incandescent gas lights for the purpose. How far the introduction of modern illuminants of this description in such buildings will be permitted remains to be seen. The fumes and products of combustion of such sources are here of little moment. It is interesting, however, to observe that in St. Andrew's Church, Sunderland, and also in the Albert Hall, London, Excello arcs have been utilized by the Union Electric Co. for this purpose.

There would not seem to be any religious objection to the use of various

modern methods of lighting in churches for general illumination *per se*. But footing. One could not readily expect that, for example, the burning candles,

FIG. 9.—Illumination of Yarmouth Parish Church.
[For the use of this block we are indebted to the courtesy of the *Journal of Gaslighting*.]

FIG. 10.—Interior of St. Michael's Church, Heavitree, Exeter, Lighted by Gas.

naturally questions of ceremonial involving the use of light are on a different in the sense of religious service, could be replaced by the convenient electric

light, or by incandescent gas lights controlled by a pneumatic switch. The sacred associations of the wax candle (which in the case of the Eastern and other churches must be made of wax of a special composition), and the continuously burning oil lamps, have, however, come to be associated with the general illumination to some extent, and perhaps on this account there is still a desire in many quarters to abide by the older illuminants. For instance, we see in Fig. 12 a view of the famous Bevis Marks Synagogue—the oldest in England—where fixtures of a special shape of Dutch origin and design, utilizing several tiers of wax candles, are employed. For permission to reproduce this photograph acknowledgment must be made of the courtesy of the Haham. These fixtures are of a unique character, with many historic associations attached to them. The illuminating engineer might easily point out that the candle is in itself an inadequate form of illuminating apparatus, and that the particular fixture shown, with the brass projection immediately beneath the lights, probably absorbing a very large percentage of available downward illumination, is also inefficient. In this case, however, it is probable that such considerations would not be allowed to weigh against the traditional method of lighting, and the writer was given to understand, when the lighting of the Synagogue was under reconsideration a few years ago, during the bicentenary celebration

Fig. 11.—Illumination of St. Andrew's Church, Sunderland, by Flame Arcs.

of its foundation the authorities decided to retain the exact original arrangements, which are modelled on those of the celebrated Amsterdam Synagogue; there are, however, other cases in which gas or electric light have been installed.

even illustrated the use of festoons of glow-lamps, &c., for the purpose of Christmas decorative effects.

Again, it is reasonable to argue that in many churches there are various objects of special significance to which attention is to be drawn, and this end

FIG. 12.—Illumination of Bevis Marks Synagogue by Fittings of Dutch Design with Wax Candles.

could be achieved by a wise use of extra local illumination. In the Catholic Cathedral in Westminster, for instance, an immense image of the Figure on the Cross is hung in front of the choir, and this is presumably

On the other hand, it is possible that electric light, wisely applied, might be of service in certain forms of decoration, &c., in religious ceremonies. Mr. E. G. Perrot, in a recent paper before the Illuminating Engineering Society,

intended to be the object of special attention. One would therefore suppose that the surroundings might be allowed to be illuminated in a subdued manner, but that this object might be made to stand out by special use of extra local light.

There are also frequently pieces of carving, frescoes, and memorial tablets, &c., that might be treated in the same way. In Fig. 13 may be seen a wall lamp utilized ıor purposes of general illumination, and possibly quite correctly so. In some cases, however, where the carving surrounding the bracket is of a very special character it would be a mistake, from the æsthetic standpoint, to use a lamp in this way, because the eye would naturally be unable to observe the carving in comfort with the bright light in front; in such a case the natural course would be to use a shaded lamp, so that the carving itself is more brightly lighted than its background, and therefore stands out, and to make quite separate arrangements for the general illumination. In the case of memorial tablets this suggestion seems specially pertinent; for of what value is it to erect an expensive tablet "in memory" of some benefactor and then to place the same in some obscure and ill-lighted corner, with the result that the plate is both out of sight and out of mind?

FIG. 13.—Wall-fixture, Church of St. Jürgen, Kiel.

One may also contemplate the possibility of luminous signs finding their way into churches, in the form of texts, &c. By "signs" we need not understand outline effects with naked glow-lamps which are admittedly inartistic and wearisome to the eye, but transparent devices which so far from being disagreeable, might, rightly conceived, be a very valuable addition to the decoration of the church; certainly the prevalent conditions of

illumination in many churches only admit of the texts, &c., being read with considerable discomfort, even after the eye has fortuitously discovered them. Actually, if such texts are really intended to be constantly kept in mind, they ought to be illuminated with a corresponding intensity in order that attention is involuntarily attracted. Similar consideration holds good for the illumination of notices of the order of hymns, &c., such as are shown in Fig. 13.

On the other hand, during the service of the Church it seems right that the illumination of the choir should be higher than the remainder of the building, both because the choristers are called upon to be constantly reading music and text, and also because the part of the church is, for the time being, the central point of interest.

In this article the author has only been able to touch briefly upon a few of the many interesting points that arise in church lighting, without attempting to lay down the law or suggest how they are to be met in detail. Many of these questions are still the subject of much general misapprehension, partly because the views of the clergy and others who are directly interested are rarely given full expression. When one considers the effect of the appearance of the church as a whole to the worshipper, and the great value set upon the associations and architecture of old churches and cathedrals, even by those who do not profess to be interested in the actual religious service, one can hardly doubt the existence of a great field for experiment in devising methods of illumination to show off all these features to the best advantage. Once more, it is only through *eyes that* these features are perceived; surely, therefore, it is absolutely essential to minister to their comfort by securing that the method of illumination is physiologically correct, and to take all possible care that the contents of the church are made interesting and visible by the lighting adopted.

In addition it can hardly be questioned that the use of light, as a means of decoration *per se*, and especially for the creation of artistic colour effects, might be studied with great advantage. The use of coloured sources to form effects of this kind might conceivably provide an entirely new field of artistic enterprise for the artist and on a far greater scale than he can hope to employ in the picture.

And lastly it may be repeated, too great stress cannot be laid on the importance of paying attention to the lighting of such unique national buildings as Westminster Abbey, St. Paul's, and our cathedrals. Of Westminster Abbey it is perhaps more true than of any other building of the same type, because it serves uses quite apart from its value as a church. Some remarks on the existing system of illuminating the abbey have already been made by Mr. Chas. Baker (*Elec. Review*, Jan. 17th, 1908). The method of lighting has been recently modified by the introduction of inverted incandescent gas burners, but the fixtures over the aisles still utilize candles provided with glass shades.

Naturally the æsthetic possibilities of the building need very careful cherishing, and the views of those who habitually advocate a subdued illumination—the dim religious light that has come to be associated with buildings of this nature—deserve careful consideration. At the same time it must be recognized that if the objects of interest collected in the Abbey, and the mementoes to the great dead and the accompanying inscriptions are really to serve their purpose, they must at least be visible, and on a dark day many of them are not as easily distinguishable as one could desire. This is a building which is systematically devoted to the honouring of the memory of national heroes and to the preservation of mementoes of great national incidents. It is being constantly used on occasions of great national interest and for ceremonials of a unique and varying character.

In important cases of this kind, therefore, it is to be expected that the method of lighting, which is in this case so vital, and has to meet so many exceptional requirements, should be the subject of such authoritative and careful study as to be above criticism.

Church Lighting.

By Emile G. Perrot.

(Paper read before the Illuminating Engineering Society, April 24, 1908.)

From the very beginning light has played a most important part in the life of the world. Shut out light from any living thing—plant, brute, or man—and part of life itself is taken away. As light is necessary to the fullness of physical life, in like manner the spiritual life of man craves as its perfection spiritual light.

The old law prescribed a seven-branch candlestick as part of the sacred treasures to be kept before the eyes of the people; when Christ came he voiced the need of men's souls when he proclaimed: "I am the Light of the World." As a symbol of Him, the Light of the World, the early Christians lit candles in the dark chambers of the catacombs. Symbols these lights were, indeed, but they served the added purpose of illumination.

So, then, the architect, whether designer of lofty cathedral or lowly church, must consider light both symbolic and illuminant.

In the Dark Ages, the great cathedrals were content with "the dim religious light" that Milton speaks of, coming through the rich colours of the great stained-glass windows. In the advance of science, religion caught the benefit, and flooded its temples with the imprisoned sunlight let free from coal or oil. When, later, electricity was employed, religion seized the new light to serve its purpose.

Religion, as we know it in the twentieth century, has formed itself into two great bodies, which we may term the evangelical and ritualistic. To light a church so that the lamps may serve the practical purpose as illuminants, and at the same time keep the religious symbolism in the spirit of each of these great divisions, is the problem of church lighting that I propose to discuss.

The evangelical church holds specially to the Scriptures, and the key-note of its service is the spoken word of the expounder of the Holy Book. So light must fill the auditorium, must centre on the preacher, as symbol, of the Heavenly Light that he teaches, filling men's souls.

In the other great division, a subdued light must envelope the congregation as befits those attending on great mysteries, and the light must centre on the altar, shining against the darkness of the background, appearing above all else in the church, as symbol of the Light of Heaven resting on the mysteries.

Thus we have, in general, the thought underlying the scheme of lighting for churches of both divisions.

As the problem of lighting evangelical churches resolves itself into that of general illumination, the treatment of such buildings can best be made to follow the general rules recognized as a standard for the lighting of auditoriums; a few examples will serve to make the matter clear.

The problem of lighting ritualistic churches, particularly Roman Catholic churches, is one that requires more study, since the predominance of the symbolical over the practical is very marked. There is an added problem in these churches of decorative lighting in addition to the practical and symbolic lighting. This of late years has become very marked, due to the ease of obtaining decorative effects with the use of the many sizes and styles of electric lamps. A scheme for lighting for a Catholic Church which does not include facilities for decorative lighting around the sanctuary where the altars are placed is incomplete. While the use of candles on the altars is required by the rubrics of the church, and they must be used, the added use of electric and gas candelabra makes it possible to obtain decorative effects in light for celebrations which far surpass the effect of the candle light.

One reason why electric decorative lighting has come into play in this church is due to the fact that as the church proper was lit by electricity, the insignificance of the illumination of the altar by candles alone became very

apparent, and as the altar is the object for which the church exists, and in its symbolical sense should be the richest part of the church, it was necessary to add electric illumination to this part of the church also.

To come now to the actual working out of these principles to concrete problems, it would be well to endeavour to establish rules for guidance which can be used in most cases. In examining the general form of evangelical churches, it is found that in plan they may be grouped as follows: Square plan, Rectangular plan, and Greek Cross plan, all usually consisting of one clear span. The church may or may not have a gallery, but, as a rule, the floor area in the centre must be illuminated from the high ceiling above. Usually it is preferable to hang chandeliers from points each side of the centre of the building. The use of central chandeliers is, as a rule, an unhappy solution, and should be avoided unless the architectural treatment of the ceiling is such as not to permit of the use of two rows of fixtures; then the use of one row or one central fixture must be resorted to.

The lighting of the chancel should be such that ample light falls on the preacher. Should there be a chancel arch, concealed lamps around the arch produce a very impressive effect.

Should a gallery be used, the part of the church under the gallery can best be lit by ceiling lamps under the gallery, or lamps can be arranged around the columns near the caps. If there is no gallery, side lamps on the walls are sometimes necessary to supplement the light from the ceiling. There is no reason, though, why ample light cannot be arranged for in the ceiling. The one point to bear in mind is not to have naked lamps in line with the vision of the congregation. The use of brackets with naked lamps on the wall back of the chancel is injurious to the eyes of the people, and should be avoided.

Should there be a dome or skylight in the centre of the ceiling, rows of lamps arranged to suit the architectural motives can be used instead of ceiling pendants. When open truss-work occurs, the fixture should be suspended from the trusses.

A very effective method of lighting a decorated ceiling is to conceal the lamps on top of a cornice and project the rays upwards; if there is no cornice, the top of column capitals can be built with a recess to receive a number of lamps, and the light projected from these points.

Very frequently it is possible to light the auditorium without the use of ceiling fixtures, dependence being placed on lamps around the walls. While the use of ceiling pendants seems to be a popular method of lighting, it very frequently happens that a clear view of a very beautiful ceiling is interrupted by unsightly chandeliers.

Turning next to the lighting of ritualistic churches, the problem is found more complex. As outlined above, symbolism plays an important part in the design of such churches; so much so as very frequently to determine the shape of the floor plan. The cruciform plan is the one most generally used for large churches, consisting of a nave and two side aisles across the church, and the nave transepts and apse for the three divisions of the length of the church. Of course, all churches do not have side aisles, nor do they all have transepts, but this form of floor plan is symbolically correct, as it represents the emblem of salvation, namely the cross.

Formerly the common method of lighting was to arrange pendants from the apex of the main nave arch, thus making a row of chandeliers in the middle of the church. The side lamps were usually arranged around the columns or piers, sometimes in the form of a corona, and sometimes as brackets.

With the advent of electric light, greater freedom of arrangement of the lamps became apparent; hence marked progress was made by arranging rows of electric lamps in cornices or other architectural features, doing away with the need of chandeliers. However, a combination of chandeliers and cornice lamps has become very common, due to the marked decorative effect of outlining the main architectural motives by means of lamps. This arrangement was even attempted in former days with gas lighting.

The arrangement of lamps about the sanctuary where the altar is placed requires the utmost care, each individual church being a law unto itself. While it is possible to outline general rules to be observed for lighting this part of a church, the problem usually demands more than the science of an illuminating engineer, coming more under the head of decoration.

For instance, in Catholic churches, there are certain services and parts of the service which require special lighting effects, due to the season of the year, the nature of the services, and whether the Blessed Sacrament is exposed or not. For grand celebrations, special decorative effects in lighting and decoration with plants and flowers is resorted to. In one service of the church on

Good Friday there is a part where total darkness reigns for a few seconds, and then instantly a flow of light fills the church. While it is not the desire of the church in any way to attempt matter to introduce effects in lighting which will not destroy the real meaning of the service.

Modern development of lighting has led to the placing of lamp-bulbs in ornaments

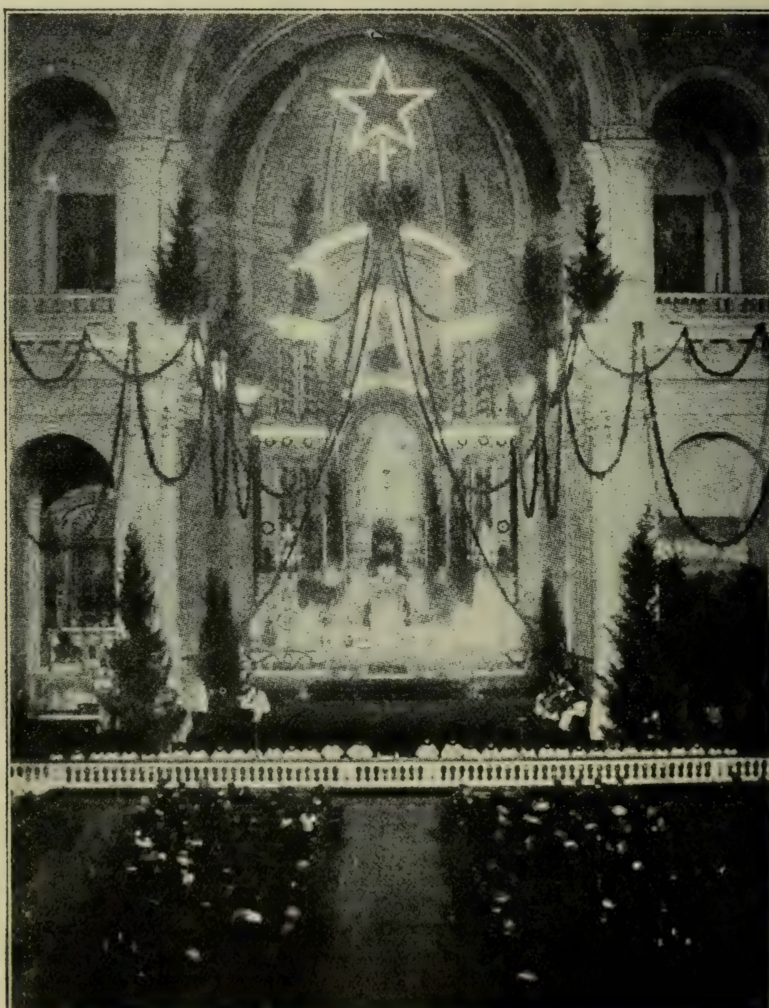


FIG. 1.—Ritualistic Church.
Decorative Lighting and Floral Effects for Christmas Celebration.

theatrical effects, it is the intention to make the exterior signs an expression of the interior feeling one should possess in attending the service. As all of these services are to be performed in a strictly liturgical manner, it is a very delicate in the moulding, thus doing away with many costly fixtures. Rosettes are very suitable ornaments for the inclusion of lamps in this way, enabling the lamp to serve its practical purpose of illumination and also to serve as a decoration.

The Lighting of Churches by Acetylene.

BY OUR PARIS CORRESPONDENT.

THE majority of the great cathedrals and places of worship in France are, probably, to be found in towns of some consequence, where gas and electricity are available as means of illumination. Nevertheless there are, of course, also many celebrated churches, famous for their architecture, and receiving a large number of visitors each year, situated in more or less remote districts.

An example of such a church is Notre Dame de Salette, in l'Isère; the nearest village has only about 500 inhabitants, but the church attracts about 30,000 pilgrims yearly.

In the case of greater number of buildings of this class it has been found preferable to retain the ancient system of illumination, consecrated by age and tradition; wax tapers and candles are, therefore, still employed. The light yielded by such sources is naturlally but feeble; yet they are used rather for purposes of decoration than with the intention of providing light to see by. At the present time, however, a certain number of progressive ecclesiastics have adopted acetylene.

On this occasion the author will not discuss the question of cost; some remarks on this subject have recently been contributed to *The Illuminating Engineer* (March, 1908). It may be pointed out, however, that acetylene-lighting is certainly cheaper than candles as regards running costs. The cost of installation must naturally depend upon the nature of the church to be illuminated, but on the ground of cost alone, acetylene has proved acceptable for the lighting of churches in remote districts.

One very important point to be considered, however, when the lighting of public buildings is in question, is the æsthetic aspect of the matter. In the case of churches it may naturally be inquired in the first instance how far acetylene is open to objection from this standpoint. The installation of acetylene is probably as simple and easy to conceal in this respect as any method of lighting well can be. The small pipes conveying the gas can usually be completely hidden among the innumerable architectural embellishments. As regards the quality of light, the resemblance of acetylene to daylight enables it to be used with special success for the illumination of works of art, where correct colour-definition is needed. But we find ourselves compelled to face the inquiry whether, from the architectural standpoint, it is necessary to *illuminate* churches, in the strict sense of the word.

This is a question to which it is difficult to return a definite answer either negative or affirmative. For example, take the magnificent Spanish gothic cathedral at Barcelona; it is contended that the deep shadow in which the nave of this church is bathed helps to emphasize the character of its lines and the general impression of severe gradeur. Others explain that this shadow gives rise to an impression in sympathy with religious worship. This may be true. On the other hand, it is advisable to draw a sharp distinction between shadow and complete obscurity, and to bear in mind that worshippers often wish to read, and ought, in this case, to receive the requisite illumination to enable them to do so.

A number of churches were illuminated by acetylene quite early in the history of its development, The cathedral at Digne (Basses Alpes) was lighted about ten years ago by 150 acetylene burners, and the cathedral of Uzès likewise. Among cathedrals more recently illuminated we may make mention of that at Dôl in Brittany where 180 acetylene burners are installed, and of Le Fresnais, also in

Brittany, where a very complete installation of acetylene, costing as much as 8,000 francs, was adopted; suspended over the main altar of this church is a superb cluster of 30 burners. In these cathedrals acetylene-lighting forms one of the regular features of the illumination; in other cases, it is utilized only on special occasions, fêtes, &c.

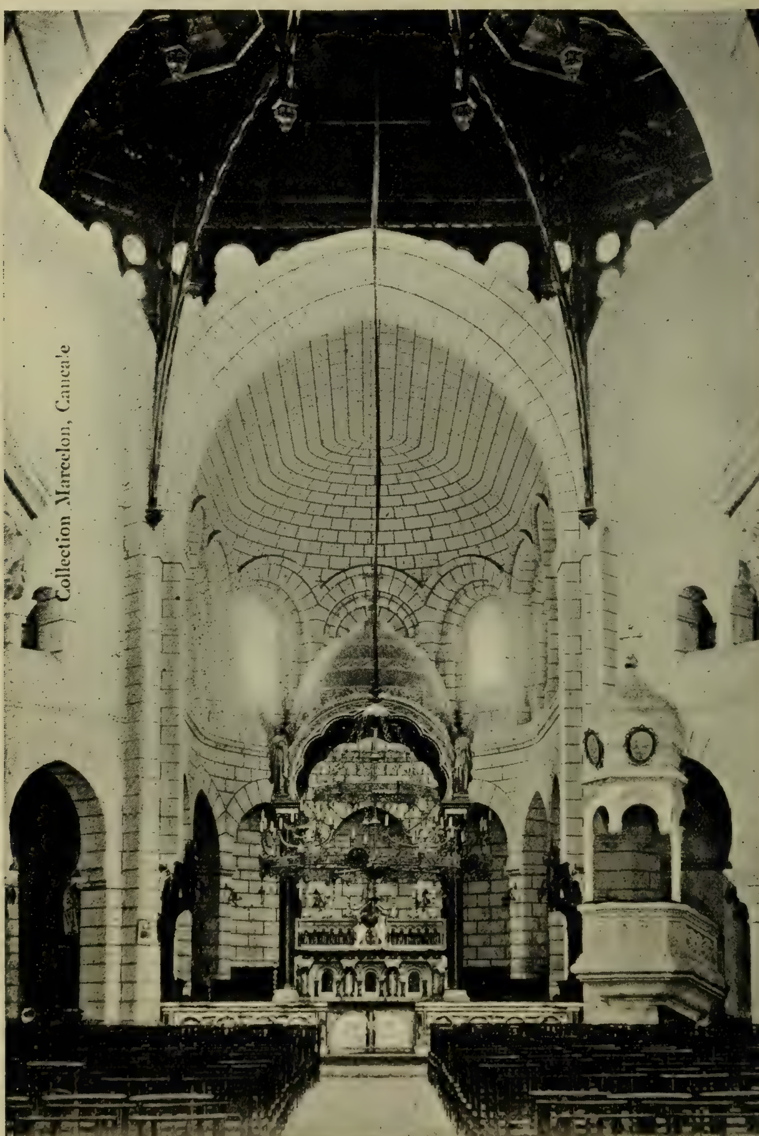


FIG. 1.—Interior of Church at Le Fresnais.
Before the Altar can be seen a cluster of thirty Acetylene burners.

In many parts of France the churches themselves form only part of a group of buildings belonging to some religious body. For instance, there is the chapel of Notre Dame de Lourdes at Herouville near Caen, the proportions of

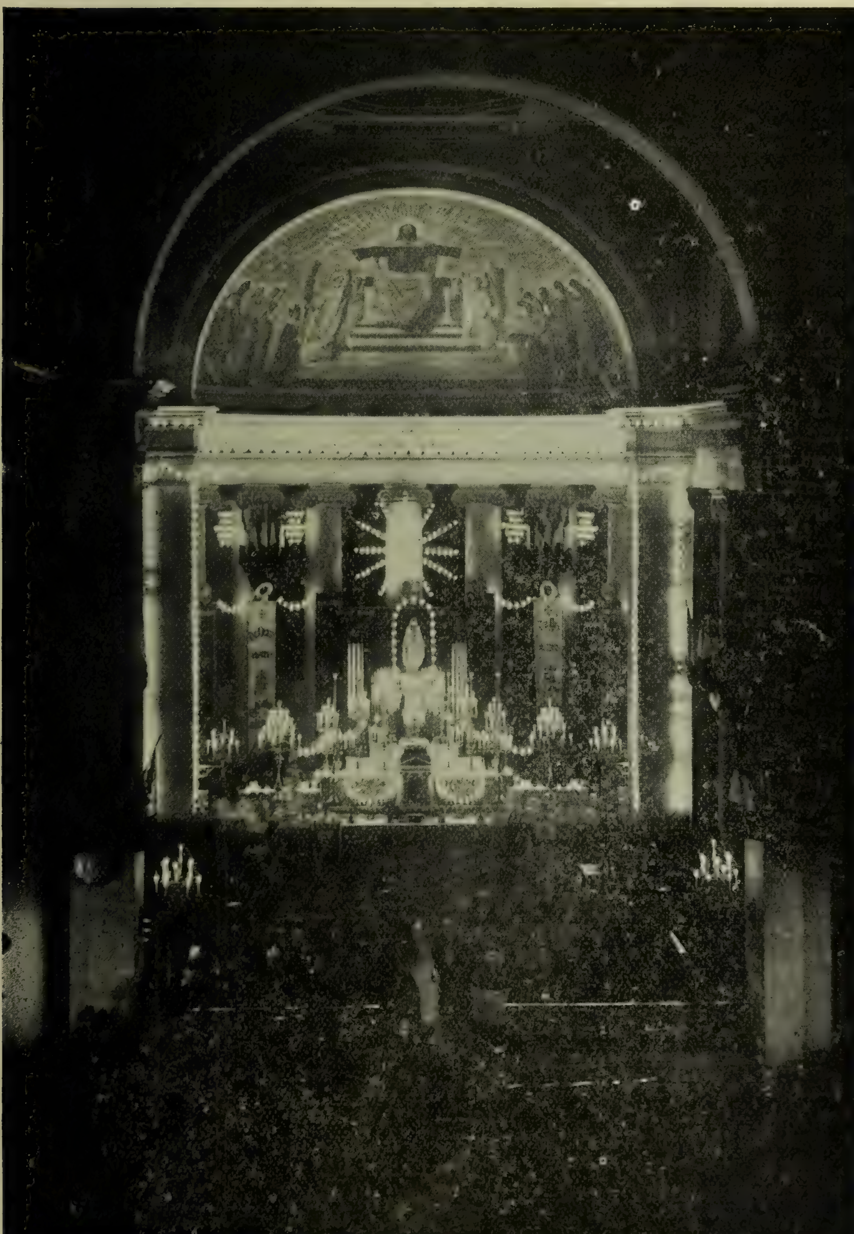


Fig. 2.—Church of St. Germain.
Main Altar illuminated by Acetylene for Christmas Celebrations.

which are modelled on the plan of the celebrated basilica of Lourdes; the chapel of the religious community of St. Pern, where hospitality is given to the aged and indigent, lighted by about 500 acetylene burners; the chapel of the Grand Trappe de Soligny (Mayenne), part of the convent of the Trappist monks, where 200 acetylene burners are used regularly for purposes of illumination; the monastery at Evron, &c. The installations in these communities are all relatively old, that at Soligny dating from 1897.

Among the many churches which, while not employing acetylene under ordinary circumstances, do so on special fête-days, mention may be made of the basilica of St. Cernin at Toulouse, and St. Germain-en-Laye; the latter merits special attention.

St. Germain is a locality celebrated both in the history of France and England. It was here that James died after his dethronement. The town has a population of about 17,000 inhabitants, supplied with both gas and electricity. These methods of illumination would, doubtless, have been applied to the lighting of the church of St. Germain, had it not been considered that acetylene was more suitable for the purpose of obtaining the desired decorative effect. The organization of these decorations was under the charge of M. Lecoeur, who, it may be remembered, also undertook the lighting of the premises of the Office Central de l'Acetylene on the occasion of the Congress in 1906; to him the writer is indebted for the photograph illustrating the lighting of the Grand Altar in the church of St. Germain, as it actually appears during the fête at Christmas.

A circumstance of interest in this temporary lighting is the use of tubes of dissolved acetylene, which enable the length of available piping to be considerably reduced, the cylinders containing the exact amount of acetylene required during the fête.

The total number of burners employed for decorative effect is 2,000; they consume in the course of the evening about 3,000 litres of acetylene. The burners are surrounded by transparent globes, and arranged on a series of balustrades amid ornamental foliage. The system of piping is so arranged that the brightness of the lights can be adjusted from time to time, as may be required, by merely turning several cocks.

The writer has had an opportunity of inspecting this application of acetylene to church-lighting on the occasions of festivals and religious ceremonies, and the result was very successful.

The Use of Flames for Decorative Purposes.

The qualities of burning flames, from the æsthetic aspect, offer an interesting example of the considerations which might guide many people in selecting an illuminant for decorative effect.

Traditionally fire and flame has come to have a certain symbolic significance as representing something alive; also the very wavy, flickering, character of naked flames, firelight, &c., which the illuminating engineer would rightly resent in a source intended for reading purposes, may actually be prized for certain decorative effects.

A dim illumination, coupled with flickering shadows, has sometimes a certain suggestive value, which a steady motionless source, like the electric light, does not possess.

In addition it need hardly be pointed out that when the feeding of such flames forms part of a religious observance, they can hardly be replaced by a modern illuminant that does not require any such attention.

The Illumination of the Church of Santa Sophia, Constantinople.

By J. B. Fulton, A.R.I.B.A.

Many Greek churches are dedicated to Santa Sophia, the most famous being that at Constantinople, built by Justinian 532–537.

Contemporary historians and the historians of all generations since, have vied with each other in writing of its beauty and grandeur. Mr. James Ferguson, the great nineteenth-century architectural writer, in his 'History of Architecture,' considers the interior to be "the most perfect and the most beautiful church which has yet been erected by any Christian people."

A dome 101 ft. 8 in. is built in the centre supported by four great piers; wall arches are built on the north and south sides, east and west great niches are formed, so that the building is continued 207 ft. 9 in. Smaller niches are formed on either side of the great niches; the former being called exedræ and the latter semi-domes.

The principal entrance leads from the beautiful Narthex into a square

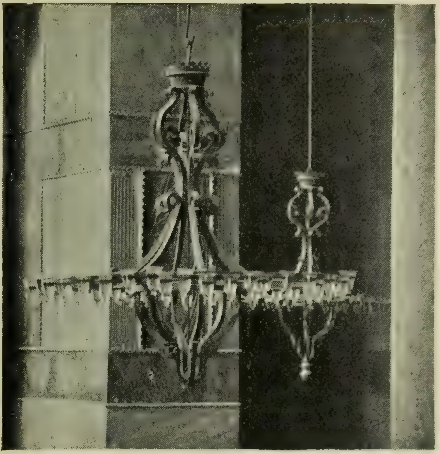


Fig. 1.—General View of Fixture carrying Small Oil-Lamps.

Fig. 2.—General View of Interior showing Rods Hanging from Dome and carrying Fixtures.

recess at the west end, and the east end is built with a semicircular recess forming the Apse.

Aisles are formed north and south, and the vaulted ceiling supports the grandeur, supporting the great hori zontal cornices, from which spring the semi-domes and arches supporting the great central dome with its pendentives, and above the cornice the

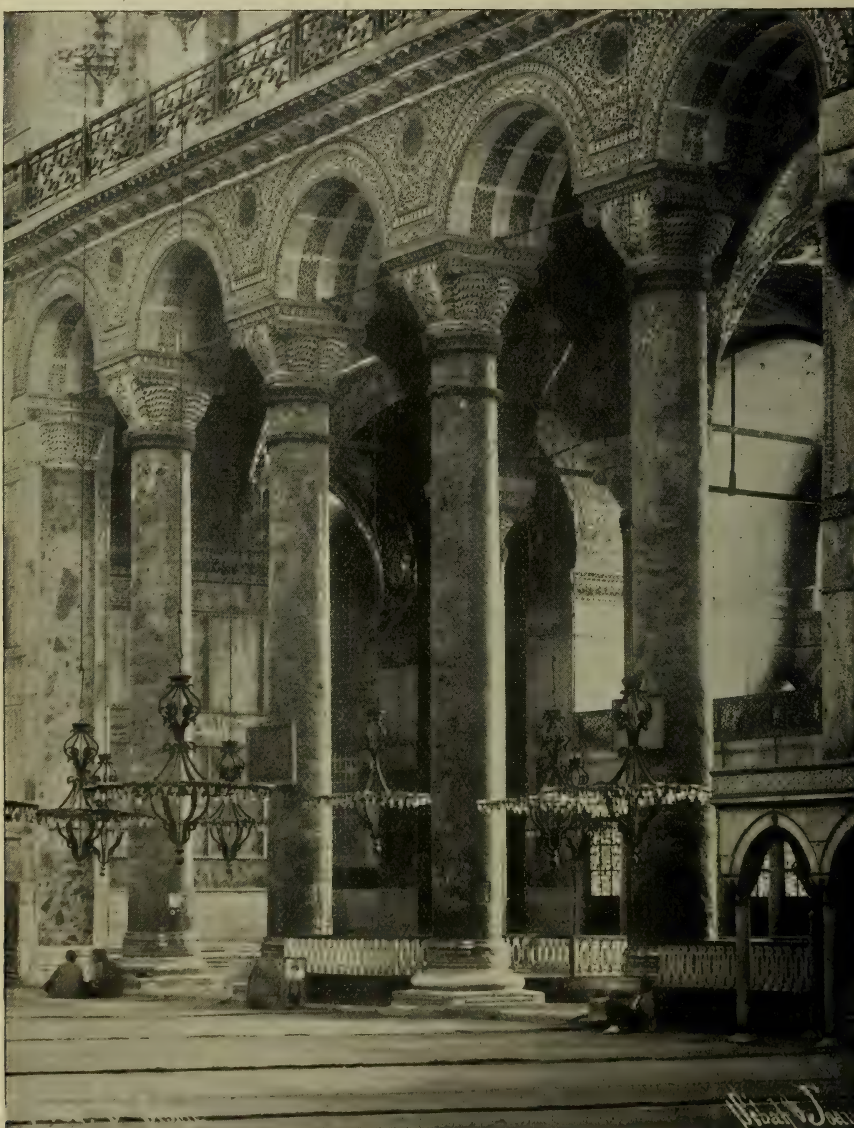


FIG. 3.—View ooking from Nave towards South Aisle.

gallery floor above. Standing at any point in this vast pendentived hall, your eye moves from one vista to another in endless variety. The columned arcades rise in solemn dome springs on forty piers, with windows between each at the base, giving to the whole a mysterious and fairy-like effect. The golden vaulting of the aisles and galleries gives colour

and distance, while all the nearer features carry your eye to the great dome crowning all. The views of the nave from the aisles and galleries are unsurpassed, the columned low vaulted semi-domes, exedra, arches, and vaulting and carry wrought iron and bronze fixtures supporting many glasses filled with oil, in which a wick floats attached to cork.

Fig 4.—View looking from Nave towards Exedrae.

richness of both contrasting with the seemingly infinite height of the nave.

The Turks converted the church into a mosque in 1453. The original or Byzantine illumination was very similar to that adopted by the Turks. Rods hang from the great dome, ribs forming a crown.

Fig. 1 gives a general view of the type of pendants employed.

Fig. 2 shows general view of the interior, with the hanging lamp fixtures, the central one being more elaborate, building up from a great circle with ribs forming a crown.

Fig. 3 is a view looking from the nave towards the south aisle, showing the pendants hanging from the iron tie-rods at springing of arches, &c.

Fig. 4 shows a view of the exedra from the nave, with a pendant in the foreground hanging from the semi-domes, showing more clearly the massing of lamps and the general decorative effect. Note also the pendants hanging from the tie-rods between arches to aisles and arches to gallery.

The height of the lamps above floor-level is about nine feet, so that the triangular ladders by the aid of which they are lighted are pulled about wherever required. The pendants are fixed, but the glasses simply rest in slots formed in flat iron.

The method of illumination is, therefore, more decorative than effective, because even when all the lamps are lighted the interior of the vast building is not very bright. It is true that the Muhammadans do not require a brilliantly lighted mosque for their worship. In the year 1847 the Italian architect Fossati restored and decorated the church, several of the illuminating fixtures being designed by him.

This interior surpasses all others, not only in construction, but also in its beauty of proportion. You grasp the whole at once: the spaciousness impresses, as the detail refines, and the atmosphere is one full of mystery and imaginative suggestion; it not only uplifts the heart, but it fills the soul with a Divine passion; it thrills your being with those exquisite sensations that a beautiful building can only inspire. The sunlight streams through the mullioned marble windows; the shadows deepen, and the peace and beauty become more mysterious. The building looks as if it were a small world in itself, the interior vieing in beauty with highest nature, the blue vault of the heavens. But the illumination is poor, and what is wanted is a veiy powerful light right in the apex of the great central dome.

A Memorial to Sir George Livesey.

A MEETING of the representatives of many gas companies, corporations, and owners of undertakings of various kinds was held in the hall of the Institution of Mechanical Engineers on Thursday, Dec. 10th, for the purpose of considering the form of a proposed memorial to Sir George Livesey. Mr. Thomas Glover, President of the Institution of Gas Engineers, presided.

The suggestions put before the meeting were three in number, namely :—

1. That a fund of £10,000 should be created to provide a Professorship of Gas Engineering at Leeds University.
2. That a sum should be devoted to providing scholarships for the benefit of those entering the gas profession.
3. That a central building should be erected for the use of members of the gas profession, containing a library, lecture-room, &c., and premises for the holding of meetings of the Council and Institution of Gas Engineers.

Mr. J. W. Helps spoke in favour of the first proposal, and Mr. Corbet Woodall, Mr. Charles Carpenter, Mr. Chas. Hawksley, Mr. Leon Gaster, and others also supported this suggestion. It was also suggested that the lectureship should be established at Leeds University, where the subject of gas engineering already receives special attention.

Mr. W. R. Herring and others also agreed to the proposal, though attention was called to a few difficulties which must be met in order to make the scheme a success.

Eventually the Chairman moved the following resolution, which was seconded by Mr. W. R. Herring, and carried unanimously :—

"That a Livesey Memorial Fund be now opened, and that contributions be invited with the object of endowing a Professorship in Gas Engineering and Fuel at the Leeds University."

The Relation Between Candle-Power and Voltage of Different Types of Incandescent Lamps.

By F. E. Cady.

(Abstract of Paper read at the Second Annual Convention of the Illuminating Engineering Society, Philadelphia, Oct. 5–6th, 1908.)

The writer investigates the relations between the voltage and candle-power of incandescent lamps.

Early work on this subject, he remarks, was devoted more to a study of the relation of candle-power to watts input than to that of voltage. In 1880, the very year in which Edison's "cardboard" lamp was produced, investigations were made* by Prof. Rowland and by Henry Morton.† In the following year Sir Wm. Thomson made some rough tests‡ to determine the illuminating power of some incandescent lamps over a wide range of voltage.

The first elaborate research seems to have been made by Jamieson§ who suggested the equation $I=\left(\frac{V}{A}\right)^6$, I being the candle-power, V the volts, and A a constant, as representing the curve of candle-power and voltage. He was followed by Dr. Voit|| who utilized the large number of tests made at the Munich Exposition, and concluded that $I=a\ E^3$, E being the watts and a a constant, gave the best agreement with the data on candle-power and watts. In a paper on 'The Characteristic Curves and Surfaces of Incandescent Lamps,' ¶Dr. Fleming states that the candle-power varies as the sixth power of the voltage. Palaz, in his 'Industtrial Photometry,' p. 212, concludes that the luminous intensity of an incandescent lamp is given by the sum of two terms, one of which is proportional to the watts consumed in the lamp, and the other to the third power of this value of watts.

Ferguson and Centre* give the equations $I=a\ E^3$, $I=b\ V^{6\cdot 6}$. Ayrton and Medley† give $I=a\ E^{2\cdot 9}$, and $I=b\ V^{5\cdot 91}$ as the results of tests on some 8 candle-power lamps which had been in use for from 200 to 300 hours. In his 'Photometrical Measurements,' p. 181, Prof. Stine comments on the apparent disagreement of filaments under any one set of conditions, and ascribes this to the physical nature of the carbon.

All of the above references concern carbon-filament incandescent lamps, but in general, the author remarks, information as to whether the filaments were treated or untreated is lacking.

The introduction of the new type of metallic filament lamp and the effort to compare its efficiency and life with that of the carbon lamp has brought up again the question of the relation of candle-power to voltage and watts. Prof. Lombardi published some data* showing the change in candle-power and watts with change in voltage, of two osmium lamps. Blau† found for a carbon lamp an 80 per cent. increase in candle-power for a 10 per cent increase in voltage. For an osmium lamp at 1·88 watts per mean spherical candle he found 40 per cent increase in candle-power for 10 per cent increase in voltage. From these data there would be for the carbon lamp $I \propto V^{6\cdot 2}$, and for the osmium lamp $I \propto V^{3\cdot 5}$. In some tests on tantalum lamps by Prof. Ambler,‡ the results for a carbon lamp at 3·76 watts per mean spherical candle gave $I \propto V^{5\cdot 5}$, and for a tantalum lamp at 2·1 watts per mean spherical candle, $I \propto V^{2\cdot 2}$. Data have been published also by Dr. Sharp§ and by Dr. Fleming, J. T. Morris and Prof. Kapp.|| In *Bulletin* No. 19, of the University of Illinois, T. H. Amrine, gives some results on a carbon, a graphitized and a tantalum lamp.

In a recent paper on the effect of change of voltage on the candle-power

* The London *Electrician*, 4, 1880, p. 271.
† *Philosophical Magazine*, July, 1880.
‡ British Association *Report*, 1881, p. 559
§ *Jour. Soc. Tel. Eng. and Electricians*, 42, 1882.
|| *La Lumière Electrique*, X., p. 87.
¶ The London *Electrician*, 14, 1885, p. 418.
* *Technology Quarterly*, 1891, p. 147.
† *Philosophical Magazine*, 39, 1895, p. 421.

* *Electrotechnische Zeitschrift*, 25, 1904, p. 41.
† The London *Electrician*, 54, 1905, p. 799.
‡ The London *Electrician*, 55, 1905, p. 941.
§ The London *Electrician*, 58, 1907, p. 602.
|| The London *Electrician*, 58, 1907, 523.

of glow-lamps* by F. Hirschauer, values of the exponent are given for a number of different types of lamps. The author, however, draws some conclusions directly at variance with those of this paper, and moreover, the data, as in most of the other published experiments, are not sufficiently complete to warrant comparison.

As noted above, the candle-power voltage and candle-power wattage relations are ordinarily expressed by equations of the form $I=aV^k$ and $I=a'E^{k'}$, where I is the candle-power, V the voltage, E the watts, and a, a', k, k′ are constants. The values of the constants have usually been obtained from curves made by finding the candle-power and watts corresponding to successive voltages. Knowing these constants, the candle-power at any voltage, or wattage, may be calculated.

If two lamps have the same candle-power at different voltages, k being the same, the value of a will be different in the two cases.

The author next enters upon a detailed mathematical study of these relations and deduces curves and tables for the purpose of determining k, and also K, a corresponding finite constant which, when multiplied by a finite change in voltage $\frac{V_x - V_o}{V_o}$, gives the percentage change in candle-power $\frac{I_x - I_o}{I}$.

In a recent article† by M. H. Pécheux, values of k are given, together with the data from which they were obtained, for a carbon, a tantalum, and a tungsten lamp. The values of k derived by the author's method, and using his data, agree exactly with those obtained by M. Pécheux.

A study of previous work where values of k have been deduced shows considerable variation with different observers, even with the same types of lamps. These variations may have been due to the methods used in obtaining the co-efficient, to actual differences in the lamps themselves in the early stages of their manufacture, or to the fact that the coefficient is not a constant but a function of the specific consumption, that is, the watts per mean spherical candle.

An uncompleted investigation recently

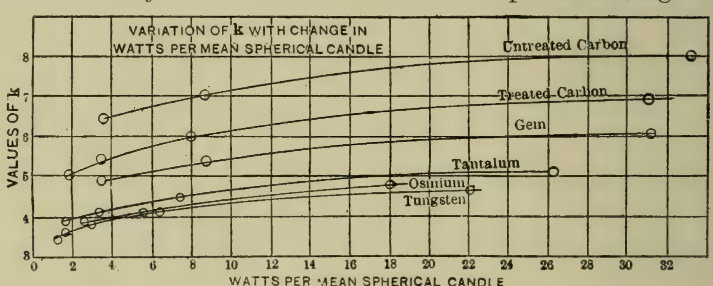


Fig. 1.

carried on at the Bureau of Standards with another purpose in view serves to suggest that k is not a constant, but a function of the specific consumption. From these data the curves in Fig. 1 are plotted.*

These curves show first that lamps of the same kind have the same infinitesimal coefficient k when operated at the same watts per mean spherical candle. Secondly, that the infinitesimal coefficient decreases as the watts per mean spherical candle decrease. Thirdly, the change in the coefficient is not large for a considerable change in specific consumption, of which the slope of the curves shown later is evidence. Fourthly, at approximately the same watts per mean spherical candle the coefficient is different for lamps of different kinds of filament, decreasing from low-efficiency lamps to those of higher efficiency.

It is evidently possible to determine with fair accuracy the value of k corre-

* *Electrotechnische Zeitschrift*, January 30, 1908.

† *La Lumière Electrique*, May 16, 1908.

* The tables given by Mr. Cady, from which these curves are deduced, are here omitted.

sponding to any desired watts per mean spherical candle within the range, even though the points lie comparatively far apart, for the reason that the slope of the curves is so slight. Thus the values of k for the different types at the watts per mean horizontal candle at which they are ordinarily used have been derived by interpolation and are given in Table I. The corresponding watts per mean spherical candle are given in the third column. They were derived from the values in column 2, by assuming reduction factors of 0·825 for the carbon and 0·80 for the other lamps.

TABLE I.

Values of k for Different Filaments at Ordinary Specific Consumption.

Type of Filament	Watts per Mean Horizontal Candle.	Watts per Mean Spherical Candle	k
Untreated Carbon	4·0	4·85	6·6
Treated Carbon ...	3·1	3·76	5·4
Gem	2·5	3·12	4·8
Tantalum	2·0	2·5	4·0
Osmium	1·5	1·85	3·8
Tungsten	1·25	1·56	3·6

The values obtained by M. Pécheux* for the tantalum lamp, that is $k=3·9$ at approximately 1·8 watts per mean spherical candle; and for the tungsten lamp, $k=3·4$ at approximately 1·2 watts per mean spherical candle agree very well with the values in Fig. 1.

In order to further test the constancy of k for lamps of the same kind of filament when at the same specific

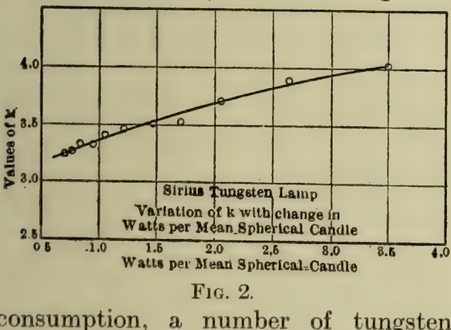


Fig. 2.

consumption, a number of tungsten lamps of different makes were photometered with this end in view. As a result it appears that values for k varying from 3·5 to 3·7 were obtained.

Figure 2 shows some results on a Sirius tungsten lamp at higher watts per mean spherical candle than most of those given in Fig. 1. The slope of the curve is quite definite. Table II. gives some values of k obtained with some 32 candle-power treated carbon filament lamps. As will be seen, the agreement with values calculated from Fig. 1, is very good.

TABLE II.

Values of k for some 32-c.p. Carbon Lamps.

Lamp	Watts per Mean Spherical Candle	k	k Calculated from Plot
1	3·9	5·5	5·4
2	3·9	5·5	5·4
3	4·0	5·5	5·5
4	3·9	5·4	5·4

While it would be highly desirable to get more accurate data on the various types of lamps photometered, and on others, and more especially on a large number of lamps of each kind from different makers, yet it is believed that the above results establish conclusively the following facts :—

That the exponent for change of candle-power with change of voltage is not a constant, but a function of the watts per mean spherical candle ; that this exponent is different for different types of filament, but probably very closely the same for lamps of the same type of filament when operated at the same watts per mean spherical candle ; that the value of the exponent decreases as the watts per mean spherical candle decrease.

It follows therefore that an equation of the form $I=aV^k$ where a and k are constants does not represent accurately the data for filaments of any material. The equation must have two or more terms, and an effort should be made to find the forms and constants of the equations for various kinds of filaments.

The writer desires to acknowledge his indebtedness to Dr. E. P. Hyde for many valuable suggestions, and to thank him and other members of the photometric section of the Bureau of Standards for assistance in preparing this paper.

* *Loc. cit.*

CORRESPONDENCE.

Daylight Illumination.

SIR,—The interesting paper read by Mr. Lewinson before the Illuminating Engineering Conference at New York (*Illuminating Engineer*, November, p. 943), contains an inquiry as to why a daylight-illumination of at least 20 foot-candles is necessary for ordinary reading purposes where the eye is satisfied with 2 foot-candles of artificial illumination.

This is, apparently, based upon a single incorrect observation, and is obviously erroneous; for if 20 candle-feet of daylight-illumination in rooms were really necessary, nearly every office in London would require artificial illumination all day throughout the greater part of the year. I have just measured the daylight - illumination upon a very small scale-drawing upon which two draughtsmen were working. At 2 P.M. (Dec. 17th) in a very good room it was 1·3 candle-feet; at 3 P.M. the illumination having dropped to 0·8 candle-feet, it was moved nearer the window; at 4 P.M. artificial light was necessary, and it was taken outside on to a balcony, where, under a day-light-illumination of 2·5 candle-feet, it would be read more clearly than under an artificial illumination of 2·1 candle-feet inside. The central parts of very few rooms have a daylight-illumination exceeding 1,000 of the outside light, and would only receive 20 candle-feet from an outside illumination of 20,000 candle-feet. An outside illumination of 2,000 candle-feet outside the direct rays of the sun is quite exceptional.

Yours faithfully,
P. J. WALDRAM.

Publications Received.

AMONG other publications recently received we have to acknowledge the receipt of the *Transactions* of the **Illuminating Engineering Society** for October, 1908; this is devoted to the first section of the papers read at the recent Convention in Philadelphia.

Geometrical Optics, by **Val. H. Mackinney** and **H. L. Taylor** (J. H. & H. Taylor, Tenby Street North, Birmingham), is a brief treatise based on the "Curvature System" of treating optical problems; with this we hope to deal in greater detail shortly.

Berechnung und **Konstruktion der Einspritz-Kondensatoren und Luftpumpen,** by **J. Jantzen** (Verlag von Dr. Max Jänecke, Hannover).

The New Business Report of the **National Commercial Gas Association** of the United States for 1908; a well got-up and readable publication, containing articles dealing with many different business aspects of the sale of gas for lighting and other industrial processes.

The publication of the proceedings of the eleventh Annual Convention of the **International Acetylene Association,** held in Chicago, U.S.A., in 1908.

We observe that the **list of lectures and papers** to be read at the **Royal Institution** in the course of the early part of this year, contains some items of exceptional interest.

The Christmas series of Juvenile Lectures is to be delivered by Prof. W. Stirling, the subject being 'The Wheel of Life.'

Among other papers which may be of more than casual interest in the light of the illuminating engineer's wide scope of action may be mentioned 'The Evolution of the Brain as an Organ of Mind,' by Prof. F. W. Mott, M.D., F.R.S., F.R.C.P. (Feb. 23, March 2, 9, 16, 23, 30, at 3 o'clock) and 'The Critical Faculty,' and 'Sight and Seeing,' by Prof. Sir H. von Herkomer, C.V.O., D.C.L., LL.D., R.A. (Jan. 23 and 30, at 3 o'clock).

ERRATUM.—P. 1051, December, 1908. In line No. 6, in first column, for "one" read *ten*.

REVIEWS, ABSTRACTS, AND REPRODUCTIONS.

"Lux" or "Meterkerze."

By Prof. L. Weber.

(Abstracted from the *Elektrotechnische Zeitschrift*, Nov. 26.)

Prof. L. Weber has kindly sent us a reprint of the above interesting communication, in which he remarks on the confusion that seems to exist as to the conception of the true meaning of these two quantities.

Dr. Monasch, in a recent communication dealing with this matter,* suggests that the "Meterkerze" was originally founded on the value of old German "Vereinskerze," and that the well-known figures of Hermann Cohn are therefore subject to correction (1 H.K. = $\frac{1}{1\cdot 2}$ Vereinskerze), if expressed in terms of the modern unit.

Prof. Weber, however, considers this a misconstruction of the term "Meterkerze," which originated from him. The expression was merely intended to describe the illumination produced by a unit of light one metre distance from the surface illuminated. In any case in which any doubt as to the prescribed unit existed, he invariably added mention of the unit intended, *e.g.* "Spermaceti-Meterkerze," "Hefner-Meterkerze," &c. Moreover, since Cohn's figures were based on communications from Prof. Weber, the latter considers that the numbers 10 and 50 Meterkerzen were naturally intended to be expressed in Hefnerkerzen, and not the old Vereinskerze.

In any case the addition of "Hefner," "Pentane," "Carcel," &c., to the term would invariably make it quite clear what unit was intended.

But the term "lux," by itself, *does* afford scope for such misconception, for at least the following four definitions have been suggested :—

1. The word proposed by Preece signified the illumination produced by an English candle at a distance of 12·7 English inches (1 in. = 25·4 mm.).
2. Lux means $\frac{J}{r^2}$, where r = 1 metre, and J the unit of light in use in the particular country concerned.
3. Lux means $\frac{J}{r}$ where r = 1 metre, and J the desired international unit of light.
4. Lux means $\frac{J}{r^2}$, where r = 1 metre and J = 1 hefner-candle.

The first of these definitions hardly calls for consideration, as it is not likely to be adopted in Germany. As regards definition No. 2 one would be obliged, in order to prevent all possibility of misunderstanding, to create ugly compound additive expressions such as Hefner-Lux, Carcel-Lux, Candle-Lux, or even Candle-foot-Lux, &c., and this method can hardly be advocated.

Definition No. 3 was proposed at the Geneva Congress, and would indeed present considerable claims to recognition, if only an international unit of light were accepted. Unfortunately this is not so, and we are driven to fall back on No. 4, according to which "Lux" is identical with "Hefner-Meterkerze."

In this connexion it may be urged :—

1. That the word "Meterkerze" is not scientifically desirable, on account of the convention prescribed by such words as "Kilogram-meter," "Voltampere," &c., which designate the sum of the quantities.
2. That an international unit of intensity of illumination is extremely desirable.

As regards the first of these contentions, it may be pointed out that, though it is not easy to suggest a suitable "portmanteau-word," composed of "Kerze" and "Meter," which would convey the correct arithmetical connexion of $\frac{\text{Kerze}}{(\text{Meter})^2}$; the danger of misconception is hardly sufficient to justify the abandoning of an expression so simple and easy to understand.

It is, of course, to be admitted that an international unit of intensity of illumination is very much to be desired, but an international unit of light is at least equally important. And how is it possible to establish the former before the latter has been determined upon ? Is it likely that illuminating engineers in any country will utilize a unit of intensity of illumination, which is independent

* See *Jour. für Gas*, &c., 1907, p. 1143; *Illuminating Engineer*, Feb. 1908, p. 150.

of the local unit of light? It is extremely improbable that any nation that has not adopted the Hefner unit would accept the "Lux" in the sense of definition No. 4.

In addition it may be pointed out that, though the acceptance of the word "Lux" in Germany has certainly been very general, the "Meterkerze" has been yet more universally recognized, and now occurs not only in works on illuminating engineering, but likewise in the literature of meteorology and school hygiene, and if any one is asked what he understands by Lux, he will reply that it means a "Meterkerze."

On these grounds it does not seem advisable to recommend the adoption of Lux in this sense, as an international unit. Only in the event of the Hefner-candle becoming recognized as an international unit, could the word Lux be regarded as an improvement on "Meterkerze." But, unfortunately, of this there is no immediate prospect.

It only remains to consider whether, in countries in which the Hefner-candle is used, the word "Lux" is to be adopted in preference to the "Hefner meter-kerze," but with the same significance, and this preference for the Latin word "Lux" is clearly unjustifiable.

In conclusion, therefore, the author feels that no other way is open but to abide by the "Meterkerze," pending the choice of an international unit of light. In cases of possible misunderstanding, we may term it "Hefner-Meterkerze" or "Meterkerze (Hefner)," or abbreviated "M.K." or "M.K.(H.)."

In England and France the customary candle-foot, candle-meter, Carcel-mètre, Bougie-mètre, &c., will likewise continue to be used, and to facilitate comprehension of these terms by other nations, we must fall back on the Table of Comparisons proposed by Dr. Monasch.

In connexion with the above considerations Prof. L. Weber makes a few additional remarks on the subject of the unit of "surface-brightness" or "intrinsic brilliancy" (Flächenhelle). This is designated by the symbol $e = \frac{J}{s}$ or $\frac{J}{r^2}$ where J is the unit of intensity and $r = 1$ cm.

The dimensions of this quantity are thus the same as those of "intensity of illumination"; but since the unit of length utilized in this case is the *metre*, the quantities are connected by the factor (100), *i.e.*, 10,000.

Moreover, the so-called "complete illumination" of a surface element (*i.e.*, illumination from a uniformly bright hemisphere, or infinitely extended parallel planes, encompassing the element), owing to the light from a surface of brightness "e," is—

$$B = e.\ \pi.\ 10{,}000,\ \text{M.K. (Lux)},$$

thus introducing the inconvenient connecting factor π 10,000.

This factor occurs in all calculations connecting the intrinsic brightness of an extended surface, and the resulting illumination, for example, in meteorology, and in the predetermination of the daylight illumination in buildings or in the open.

In this subject we cannot avoid introducing a secondary unit in the place of, or possibly in addition to, the primary intrinsic brilliancy expressed in candle-power per square centimeter. As an example of such a unit, which has found useful practical application,* we may cite the intrinsic brilliancy created by the illumination of an absolutely dead-white surface, with an intensity of one meterkerze.

By the adoption of such a secondary unit that inconvenient factor $\pi \times 10{,}000$ disappears, and gives rise to the simplification that—

1. The intensity of illumination corresponding to "complete illumination" (as defined above), is the same as the surface-brightness of the radiating surface.
2. An absolutely dead-white surface attains unity surface-brightness by being illuminated with a unit intensity.

Prof. L. Weber considers it essential to find a place for this new secondary unit in the ordinary photometrical nomenclature. It is difficult to find a satisfactory name for the unit. Had we an international unit of light, we might retain the word "Meterkerze" for intensity of illumination, and the word "Lux" for the secondary unit of surface-brightness. We might denote this secondary unit of surface-brightness (Sekundäre Helligkeitseinheit) by "SHE (Hefner per square cm.)," and the corresponding primary unit (Primäre Helligkeitseinheit) by "PHE (Hefner per square cm.)."

Finally, Prof. L. Weber again emphasizes the true meaning of the Cohn data, the unsatisfactory nature of the use of the word "Lux" in the sense of definition No. 4, and the need for a secondary unit of intrinsic brilliancy on the lines indicated. In the event of the units again coming up for international discussion, the latter point should receive special attention.

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* 'Die Tagesbeleuchtung der städtischen Schulen in Kiel,' von L. Weber, Verlag von Lipsius & Fischer, Kiel, Germany.

Review of the Technical Press.

ILLUMINATION.

A NUMBER of articles dealing generally with aspects of ILLUMINATING ENGINEERING have, as usual, appeared in the press in the United States. **A. A. Wohlauer** and **A. J. Marshall** contribute additions to the discussion that is still in progress with regard to the exact relation of the ILLUMINATING ENGINEER TO ÆSTHETIC PROBLEMS.

A matter of considerable importance is that touched upon in an editorial in *The Illuminating Engineer* of New York for November, and also by Marshall, namely, the meaning that is being attached to the term "Illuminating Engineer." It is pointed out that very few men as yet exist who can be said to possess the qualifications of the ideal expert illuminating engineer, and that therefore the use of this term should be restricted at the present time, and not applied to all who may be interested in the subject of illumination, irrespective of their professional acquirements. In particular it is pointed out that membership of the United States Illuminating Engineering Society does not carry with it any right to be designated in this way. For this very reason the society has been termed the "Illuminating Engineering Society," and not "The Society of Illuminating Engineers."

An article by **A. E. Macallister** (*Elec. World, N.Y.*, Nov. 21), suggests a new method of making calculations of illumination, on the basis of the absorption of light from the walls and ceilings of a room. It is becoming increasingly usual, the author states, to calculate the total flux of light over a table, &c., in a room, and then, dividing by the area illuminated, to obtain the mean illumination available. But all such calculations are impaired unless due allowance is made for the light reflected from walls and ceilings. The writer suggests that it is easier and more accurate to reckon out the light lost by absorption rather than the light reflected, in making this calculation.

Two recent articles in *The Electrical Review* (Dec. 25) and *The Electrician* (Dec. 11) deal with the subject of LIBRARY LIGHTING. It is rather interesting to observe the attention that seems now being bestowed on this subject in view of the recently published paper on the subject by Mr. L. B. Marks (*Illuminating Engineer*, Nov. and Dec., 1908), and the editorial comments in the latter number. The first of the two articles referred to is of particular interest, containing a number of comments on the lighting of various London public libraries.

A very important article by **Prof. L. Weber** (*E. T. Z.*, Nov. 26) discusses the relative claims of the terms "LUX" AND "METERKERZE" as a means of denoting the unit of intensity of illumination. The author finds the use of the former term, in its international significance, to be preferable theoretically, but he points out that there is no prospect of its use becoming generally recognized until agreement on an international unit of light is first arrived at. For the present he inclines to the view that the term "meterkerze," which is well understood throughout Germany, should remain in use in that country.

J. S. Dow (*Elec. World*, N.Y., Dec. 12) discusses the determination of the MECHANICAL EQUIVALENT OF LIGHT, dwelling specially on the physiological basis underlying such investigations and making exact knowledge difficult. Naturally the difference in the behaviour of the eye at high and low illuminations may be expected to influence the region of the spectrum for which the highest value of the equivalent, for monochromatic light, exists. The writer deduced some theoretical values for the mechanical equivalent throughout the spectrum calculated on the basis of Dr. Drysdale's determination for yellow-green light, in conjunction with the curve of luminous efficiency for the spectrum of sunlight.

An important event, to which reference is made in the United States electrical press this month, is the first annual meeting of the ASSOCIATION OF CAR-LIGHTING ENGINEERS, in Chicago last month. Most of the papers seem to have dealt mainly with the more mechanical aspects of the subject; but that the lighting of moving vehicles in general is one that would be the better for more attention will generally be admitted.

O. Vogel (*Z. f. B.*, Dec. 10) contributes a very interesting article on the TRANSFORMATION of light from one wave-length to another, and the ACCUMULATION OF LIGHT-ENERGY by fluorescent and other means. The fascination of the idea of a completely portable, adequate, and cheap phosphorescent light is one that will appeal to most people, and, though the subject can hardly be said to have

yet reached a practical stage as regards its application to commercial illumination, there is room for communications pointing out the lines of possible research in the future.

Mention must be made of a reply to the recent article by W. Veoge on the subject of the effect of ULTRA-VIOLET RAYS ON EYESIGHT, by **Drs. Schanz** and **Stockhausen** (*E. T. Z.*, Dec. 3). The authors add some more illustrations of the effect of unfavourable daylight conditions on the eye, in high altitudes, &c., owing to the presence of ultra-violet light, and also criticizes several points in Dr. Veoge's method of comparing the intensity of the ultra-violet light in different illuminants in the article referred to.

A. Hodl communicated a most interesting account of the PROGRESS OF ILLUMINATION AND ILLUMINANTS IN AUSTRI-HUNGARY during the past sixty years (*Oesterr.-Ungar. Installateur*, Dec. 5, 1908).

PHOTOMETRY.

But a few contributions of note seem to have appeared under this heading.

The paper by **C. O. Bond** at the annual meeting of the American Gas Institute on the PHOTOMETRY OF GAS, to which reference was made in our last review, is again published in several quarters, and likewise the important communication to the Institute by the sub-committee dealing with the suggested international unit of light.

J. K. Heydon (*Elec. Mag.*, Nov.) contributes some remarks on PHOTOMETRIC STANDARDS, paying special attention to the difficulties involved in the provision of standard conditions in units of the incandescent-platinum class. He suggests that a possibility of simplifying the existing difficulties might lie in the separation of the electrical or other means of heating and the actual radiating surface; to this end he employs an electrically heated platino-iridium wire, wound round a porcelain cylinder, the latter being coated with platinum black to resemble the theoretical black body.

Thorner (*Phys. Zeitschr.*, Dec. 1) describes his instrument for studying the conditions of DAYLIGHT ILLUMINATION in an interior. This illumination-tester has previously been described in *The Illuminating Engineer* (June, 1908, p. 505). The author proposes to add an iris diaphragm for the purpose of securing a progressively graduated alteration in intensity, in place of the separate "stops" previously employed.

W. Paulus (*E. T. Z.*, Nov. 28) contributes a letter containing some remarks on the subject of the proposed application of the method of rotation to metallic filament lamps in order to determine their M.H.C.P. He states that speeds of 60 revolutions per second are quite satisfactory, while even 80 to 100 can be used without danger of deformation of the filament.

ELECTRIC LIGHTING.

During the last month fewer articles than usual dealing with this subject have appeared.

The proposed TAX ON GAS AND ELECTRICITY, however, continues to excite a considerable degree of attention, recent numbers of the *Elektrotechnische Zeitschrift* containing the verbatim text of a manifesto from G. Dettmar, the secretary of the German Institution of Electrical Engineers, which is to be addressed to the Reichstag on the subject.

R. E. Neale contributes a lengthy series of comparisons on the COST OF GAS AND ELECTRICITY, mainly for lighting, in *The Electrical Magazine* for December.

Some account is also given in recent numbers of the *E. T. Z.* of the specifications referring to standard screw-threads, &c., laid down by the Verband Deutscher Elektrotechniker, and the influence of them upon the details of the manufacture of glow-lamp holders, &c. It is stated that different lamps did not always fit the sockets of another make correctly, but in future standard threads will be generally adopted.

An article by **P. Hogner** (*E. T. Z.*, Dec. 3), describes the results of some researches upon the EFFECT OF WAVE-FORM AND OTHER ELECTRICAL CONDITIONS on the PERFORMANCES OF FLAME ARC-LAMPS on alternating current circuits. The writer gives details of the candle-power of lamps, and the corresponding current and P.D. wave-form, and reaches several interesting conclusions; it is suggested that in general better results can be arrived at by utilizing a choker in place of a series-resistance.

The paper by **W. Wedding**, delivered at the Annual Meeting of the Verband Deutscher Elektrotechniker at Erfurt this year, and dealing with recent progress in electric lighting, is again reproduced in several quarters. The most recent instalment of the articles by **B. Duschnitz** in the *Elektrotechnischer Anzeiger* deal with different methods of winding and attaching metallic filaments within the bulbs.

GAS, OIL, ACETYLENE LIGHTING, &c.

An item of interest that has received some attention in the British gas journals relates to the alteration in the LIGHTING OF FLEET STREET (London). This is

to be accomplished by 1,500 candle-power Keith high-pressure lamps, 15 feet above the street-level, and consuming 25 cubic feet per hour of gas. It is also stated that the light will amount to 16 candles per foot run illuminated. The pressure at the lamps will be about 55 inches, but this will be momentarily increased to 60 inches, for the purpose of automatically controlling the lighting up and extinguishing of the lamps.

The pressure employed has necessitated special mains arrangements, and a recent letter to *The Gas World* advocates the use of self-contained lamps of the Chipperfield type, which are independent of any extraneous pressure-raising devices, and can be applied to the existing system of supply for future extensions.

There seems to be a general impression that such self-contained lamps will be widely used in gas-lighting in the future, this point again coming in for mention in a recent paper by **J. MacGhee.** The paper contains an interesting general summary of the development of pressure-lighting, and the recently introduced accessories, such as self-lighting mantles, &c. These mantles, however, are said to be hardly commercial as yet, though a type is on the market that is claimed to last for several months, and act efficiently during this time. The author also referred to an interesting instance, coming under the notice of Mr. Alex. Wilson, where roof-lighting by 28 inverted mantles, in place of the old inefficient arrangements, led to the discovery of the fact, hitherto unsuspected, that the walls of the interior badly needed repainting. These lights, it is stated, were controlled at a distance of 120 feet by a pneumatic switch. A very wise suggestion is also made to the effect that officials might with advantage be appointed in large towns for the express purpose of instructing consumers how to utilize their gas-burners and mantles to the best effect, since the results in many cases depend very greatly upon whether the preliminary adjustment of the former is correct.

A similar feeling is expressed in many of the papers read at the recent meeting of the NATIONAL COMMERCIAL GAS ASSOCIATION in the United States, it being generally agreed that the time is now past when consumers can be treated in the arbitrary manner that was too often habitual in the past. Thus **C. W. Hare** advocates that the "complaint desk" should be made specially accessible and prominent in order to encourage consumers in the belief that the gas company recognize the pointing out of real defects as a service to them, and are anxious that bad conditions should be promptly remedied.

In connexion with the improved lighting in the City of London, mentioned above, it is interesting to observe that HIGH-PRESSURE LIGHTING in the town of STUTTGART, in the Königstrasse, is the subject of an article by **E. Gohrum** in the *Journal für Gas*, &c. (Nov. 21). In this instance the lighting is accomplished partly by Pharos and partly by Selas lights, running at pressure of 1,400 and 300 millimetres respectively. It is further stated that the mantles in use last about 150 to 200 hours.

Attention should also be called to the interesting series of articles that have been appearing in the *Journal of Gaslighting* on the subject of the progress of gas-lighting in Japan. The development of illumination in such a country, where the æsthetic side of lighting, one would imagine, would receive special attention, will be followed with interest.

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Peris, P. H. Die Normalgewinde des Verbandes Deutscher Elektrotechniker und ihre Anwendung in der Praxis (*E. T. Z.*, Dec. 3, 1908).
Neale. R. E. A Series of Comparisons between Gas and Electricity (*Elec. Mag.*, Dec., 1908).
Wedding, W. Neuere Errungenschaften in der elektrischen Beleuchtung (reported, *J. f. G.*, Nov. 21, *Elec. Rev.*, Nov. 25).
Der Gesetzentwurf betr., Besteuerung von Gas und elektrischer Energie (*Elec. Anz.*, Nov. 30, Dec. 10, 1908).
Die neueren Bogenlampen, Metall-dampf Bogen (*Z. f. B.*, Nov. 30, Dec. 10, 1908).
The Quartz Mercury Vapour Lamp (*Elec. Engineering*, Nov. 26, 1908).
Metallic Filament Lamps and Prices (*Elec. Engineer*, Dec. 11, 1908).
The Association of Car Lighting Engineers. See *Illumination.*

GAS, OIL, ACETYLENE LIGHTING, &c.

Davidson, W. B. Measuring, Testing, and Recording (*J. G. L.*, Dec. 15, 1808)
Deville, E. St. Claire. Die Leuchtkraft von Steinkohlengas, Wassergas und Gemischen dieser Gäse im gewöhnlichen und im Gasglühlichtbrenner (*J. f. G.*,), Nov. 21, 1908). Paper read at International Photometrical Congress, 1907.
Editorial. Concerning Statutory Calorimetry (*G. W.*, Dec. 19, 1908).
Uniformity and Quality (*J. G. L.*, Dec. 8, 1908).
Göhrum, E. Die Beleuchtung der Königstrasse in Stuttgart mit Starklicht (*J. f. G.*, Nov. 21, 1908).
Graham, M. Japanese House and Street Lighting (*J. G. L.*, Dec. 8, 1908).
MacGhee, J. Heating and Lighting (Paper read before Scottish Junior Gas Association, *G. W.* Dec. 12, *J. G. L.*, Dec. 8, 1908).
The German Gas and Electricity Tax (*J. G. L.*, Dec. 8, Dec. 15, 1908).
The Gas Industry in Japan (*J. G. L.*, Nov. 24, Dec 1, 1908).
High Pressure Inverted Incandescent Lighting in Fleet Street, London (*G. W.*, Dec. 5; *J. G. L.*, Dec. 1, 1908).
Benoid-Gas (*Oesterr.-Ungar. Installateur*, Nov. 28, 1908).
Notes on Air-Gas and Petrol Lighting (*The Plumber*, Nov. and Dec., 1908).
Gasglühlichtbrenner, &c. (*Z. f. B.*, Nov. 30. 1908).
Gasaliers and Electroliers (*Am. Gaslight Journ.*, Nov. 30).
Meeting of the National Commercial Gas Association (*Am. Gaslight Journ.*, Dec. 14, 1908.

MISCELLANEOUS.

Fleming, Dr. J. A. The Photo-electric Properties of Potassium-Sodium Alloy (Paper read at Physical Society, Nov. 13, 1908, *Elec. Engineer*, Dec. 4, 1908).
Goldmann, A. Lichtelektrische Untersuchungen an Farbstoffzellen (*Ann. der Physik.*, No. 13, 1908, p. 449),

CONTRACTIONS USED.

E. T. Z.—*Elektrotechnische Zeitschrift.*
Elek. Anz.—*Elektrotechnischer Anzeiger.*
G. W.—*Gas World.*
Illum. Eng.—*Illuminating Engineer of New York.*
J. G. L.—*Journal of Gaslighting.*
J. f. G.—*Journal für Gas- und Wasserversorgung.*
Z. f. B.—*Zeitschrift für Beleuchtungswesen.*

PATENT LIST.

COMPLETE SPECIFICATIONS ACCEPTED OR OPEN TO PUBLIC INSPECTION.

I.—ELECTRIC LIGHTING.

26,294. Supporting filaments in incandescent lamps. Nov. 28, 1907. Accepted Dec. 16, 1908. F. Harrison, 16, Ossian Road, Stroud Green, London.

26,420. Extinguishing arc lamps (C.S.). Nov. 29, 1907. Accepted Dec. 9, 1908. Beck Flame Lamp, Ltd., 27, Chancery Lane, London. (From Deutsche Beck Bogenlampen, G.m.t.H., Germany.

27,034. Arc lamps. Dec. 6. 1907. Accepted Dec. 16, 1908. W. J. Davy, 40, Chancery Lane, London.

27,132. Arc lamps. Dec. 7, 1907. Accepted Dec. 9, 1908. The Bristol Thomson-Houston Co., Ltd., 83, Cannon Street, London. (From Allgemeine Elektricitäts-Ges., Germany.

2,153. Incandescent lamp caps. Jan. 30, 1908. Accepted Dec. 16, 1908. W. W. Buckton, 72, Victoria Street, London.

5,029. Arc lamps. Mar. 5, 1908. Accepted Nov. 25, 1908. Johnson & Phillips, Ltd., and S. Paterson, Birkbeck Bank Chambers, London.

5,415. Incandescing bodies containing zirconium. Mar. 10, 1908. Accepted Dec. 9, 1908. The British Thomson-Houston Co., Ltd., 83, Cannon Street, London. (From General Electric Co. U.S.A.)

5,596. Mercury vapour lamps. Mar. 12, 1907. Accepted Dec. 2, 1908. H. A. Kent, H. G. Lacell, and The Silica Syndicate, Ltd., 47, Lincoln's Inn Fields, London.

7,328. Arc lamps (C.S.) I.C. Aug. 2, 1907, Germany. Accepted Dec. 16, 1908. Allgemeine Elektricitäts-Ges.. 83, Cannon Street, London.

9,656. Fittings for glow lamps (C.S.). I.C. June 25, 1907, Germany. Accepted Dec. 2, 1908. Siemens-Schukertwerke G.m.b.H., Queen Anne's Chambers, Broadway, Westminster.

10,269. Arc lamp. (C.S.) May 12, 1908. Accepted Dec. 2, 1908. F. Ruzicka, 115, Cannon Street, London.

10,885. Filaments for incandescent lamps. I.C. Nov. 27, 1907, Germany. Wolfram-Lampen Akt.-Ges., 7, Southampton Buildings, London.

10,889. Carbon holders for arc lamps (C.S.). I.C. Nov. 29, 1907, Belgium. R. Chauket, 1, Queen Victoria Street, London.

12,682. Arc lamps (C.S.). I.C. July 15, 1907, Germany. Accepted Dec. 16, 1908. Allgemeine Elektricitäts-Ges., 83, Cannon Street, London.

13,539. Mercury vapour lamps (C.S.) June 25, 1908. Accepted Dec. 16, 1908. P. Haack, 7, Southampton Buildings, London.

13,661. Fittings for incandescent lamps (C.S.) June 27, 1908. Accepted Nov. 25. 1908. A. G. Bloxam, Birkbeck Bank Chambers, London. (From Siemens Schuckertwerke G.m.b.H., Germany).

17,509. Arc lamp (C.S.) Aug. 20, 1908. Accepted Dec. 2, 1908. Regina Bogenlampenfabrik G-m.b.H., and P. Hanisch, 322, High Holborn, London.

19,311. Tungsten incandescent bodies (C.S.). I.C. Sept. 26, 1907, Germany. Accepted Dec. 16, 1908. Siemens & Halske Akt.-Ges., Birkbeck Bank Chambers, London.

25,854. Tungsten and other refractory metal filaments (C.S.) I.C. December 11, 1907, Germany. Siemens & Halske Akt.-Ges., Birkbeck Bank Chambers, London.

II.—GAS LIGHTING.

25,657. Incandescent mantles. Nov. 19, 1907. Accepted Nov. 25, 1908. J. T. Robin, 7, Southampton Buildings, London. (From S. Salomon, Germany.)

26,617. Nozzles for inverted incandescent burners (C.S.). Dec. 3, 1907. Accepted Dec. 9, 1908. H. Winkler, 1, Great James Street, Bedford Row, London.

27,429. Sick-room gas-lamp. Dec. 12, 1907. Accepted Dec. 16, 1908. J. H. Hill, Amor Matris, Park Grove, York.

28,437. Controlling gas supply at a distance (C.S.). Dec. 27, 1907. Accepted Nov. 25, 1908. A. F. Gerdes, 40, Chancery Lane, London.

2,240. Incandescent mantles. Jan. 31, 1908. Accepted Dec. 2, 1908. The British Cerofirm Co., Ltd., Chancery Lane, London. (From the Cerofirm Ges., m.b.H., Germany.)

4,550. Electrically igniting gas burners. Feb. 28, 1908. Accepted Dec. 9, 1908. A. J. Hill and F. C. D. Mann, 60, Queen Victoria Street, London.

13,204. Burning off gas mantles (C.S.). I.C. Nov. 8, 1907, Germany, Accepted Dec. 9, 1908. H. Drehschmidt, 77, Chancery Lane, London.

14,307. Inverted incandescent lamps, for railway carriages (C.S.). I.C. Sept. 7, 1907. Accepted Dec. 8 1908. Ehrich & Graetz, 111, Hatton Garden, London.

17,148. Automatic ignition and extinction (C.S.). I.C. Aug. 16, 1907, Sweden. Accepted Nov. 25. 1908. E. A. Fagerlund, 18, Southampton Buildings, London.

III.—MISCELLANEOUS

21,928. Globe or shade holder for gas and electric light. Post dated April 6, 1908. Accepted Dec. 2, 1908. H. G. Richardson, 128, Colmore Row, Birmingham.

25,884. Vapour lamp. Nov. 22, 1907. Accepted Dec. 2, 1908. J. H. Miess, Birkbeck Bank Chambers, London.

1,069. Acetylene lamps. Jan. 16, 1908. Accepted Nov. 25, 1908. J. S. Warburton, 19, Stanwick Road, West Kensington, London.
5,030. Illumination and heating by vapour burners (C.S.). I.C. Mar. 6, 1907, France. Accepted December 16, 1908. L. Denayrouze, Birkbeck Bank Chambers, London.
8,427. Reflectors. April 15, 1908. Accepted Dec. 16, 1908. F. J. B. Collis, 4, South Street, Finsbury.
22,516. Incandescent vapour lamps (C.S.). D. A. Nov. 22, 1907. Accepted Dec. 2, 1908. J. H. Miess, Birkbeck Bank Chambers, London.
25,609. Reflectors (C.S.). I.C. Nov. 27, 1907, Germany. W. Müller and O. Gaebel, 111, Hatton Garden, London.

EXPLANATORY NOTES.

(C.S.) Application accompanied by a Complete Specification.

(I.C.) Date applied for under the International Convention, being the date of application in the country mentioned.

(D.A.) Divided application; date applied for under Rule 13.

Accepted.—Date of advertisement of acceptance.

In the case of inventions communicated from abroad, the name of the communicator is given after that of the applicant.

Printed copies of accepted Specifications may be obtained at the Patent Office, price 8*d*.

Specifications filed under the International Convention may be inspected at the Patent Office at the expiration of twelve months from the date applied for, whether accepted or not, on payment of the prescribed fee of 1*s*.

N.B.—The titles are abbreviated. This list is not exhaustive, but comprises those Patents which appear to be most closely connected with illumination.

Fund for Mrs. B. H. Thwaite and Young Children.

As we go to press we receive a copy of the appeal on behalf of the widow and young children of the late Mr. B. H. Thwaite, whose early death will have been noted with great regret by our readers.

We find that we are unable to find room for the insertion of this appeal in full on the present occasion, but take this opportunity of drawing our readers' attention to the widely recognized value of the late Mr. Thwaite's many inventions and scientific achievements, and the urgent need of help for those who were dependent upon him. Mr. Carnegie, with characteristic generosity, has already promised the sum of £500 conditionally on a like sum being raised by others, and we hope that a generous response will be made to this appeal.

All particulars may be obtained from the Hon. Secretary, Mr. W. H. Booth, A.M.Soc.C.E., 2, Queen Anne's Gate, Westminster, S.W.

TRADE NOTES.

We are informed that the *Phœnix Glass Company*, of New York, Pittsburg, and Chicago, has retained the *Bureau of Illuminating Engineering*, 437, Fifth Avenue, New York, to act as consulting and designing illuminating engineers, in the matter of designing or re-designing glass globes and reflectors, as manufactured by them, in order that beauty and utility may be suitably blended. *Mr. A. J. Marshall*, Chief Engineer of the Bureau, will have direct supervision of this work.

The result of this arrangement will be that the Phœnix Glass Company will be prepared to supply glassware for any class of service, and for any illuminant; and efficiency, beauty of design, and the effect of light on the eye will receive very careful consideration.

Messrs. Siemens Brothers, Dynamo Works Limited, of 6, Bath Street, City Road, inform us that in June last they fitted up a carriage upon the Great Northern and City Railway with "Tantalum" Lamps; 15 lamps in all were installed, and of these two have broken down up to date, while the remaining 13 have now run for 2,000 hours without failure or serious decrease in candle-power. Out of a large number of lamps used in the stations of this railway 75 per cent have burnt for about 2,000 hours and are still in use, while the remaining 25 per cent (excluding four lamps which broke down through mechanical defects), gave an average life of 1,300 hours. As a result of these tests, the Great Northern and City Railway propose to displace their Carbon Filament Lamps and use "Tantalum" Lamps for both train and station lighting.

We have received a notice of the *McBeth Calculator*. This instrument is devised for the automatic calculation of the illumination in various planes, and at different distances from the source, &c. It can be obtained from the Illuminating Engineering Publishing Co., Ltd., 12, West 40th Street, New York, at a cost of 6·50 dols. post paid.

We are requested to draw attention to the publication of the Twenty-seventh Edition of the '*Electrician*' *Electrical Trades Directory*, which will be available this month; for further details apply, 'The Electrician' Office, Salisbury Court, Fleet Street, London, E.C.

ELECTRICITY · ACETYLENE · OIL · GAS

The ILLUMINATING ENGINEER

Edited by LEON GASTER

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EDITORIAL.

New Illuminants and 'The Illuminating Engineer.'

SEVERAL of our contemporaries have recently passed in review the progress that has been made in the production and use of light during the past year, and the position of the illuminating engineer who is responsible for their selection and application.

His functions have been aptly described in several publications in the United States, but, perhaps, especially so in the recent address of Mr. A. Cressy Morrison before the Illuminating Engineering Society in Chicago, which we publish elsewhere in this number. This address was delivered at a meeting of the above society held by special invitation of the American Gas Institute and the National Commercial Gas Association,—an illustration of the friendly manner in which its efforts are appreciated and encouraged by the gas fraternity in the United States. Of the attitude of the Illuminating Engineering Society in inviting co-operation of this description Mr. Morrison spoke with special approval.

The progress of the last twenty-five years has indeed been stupendous in comparison with that of the centuries preceding this period. In the production of light there is now no monopoly, and the manufacturers of the raw material, whether it be candles, oil, gas, or electricity, are coming to realize that these commodities are only a means to an end, and that their real business is to sell light; and the task of the illuminating engineer is to apply this light to the best advantage, irrespective of how it is generated, provided only that it is the best available for the particular circumstances of the case under consideration.

In speaking of the great strides that have been made in electric lighting, Mr. Morrison traced the effect of the infusion of young and enthusiastic blood in the electrical profession, but also stated his conviction of the immense possibilities of future development that lay before gas. Signs of this accelerated progress we already trace in the most recent achievements of high-pressure and inverted gas lighting, but the younger generation will doubtless live to achieve yet more wonderful results. Some illustrations of new progress in this direction were provided in the Exhibition of Gas Appliances at Chicago, which, we are given to understand, was such an effective and successful feature of the gathering referred to.

The Study of the Consumer.

The services to be rendered by the illuminating engineer to the consumer are numerous, and it need not be assumed that the reduction in his bill is by any means all that he desires. In many cases, of course, economy must always remain the main factor to be considered. In many others, however—indeed one might probably suppose in the majority of private installations—the consumer is willing to pay a reasonable amount, if only he can feel confident that he is using what he purchases to the best advantage, and that those whom he pays have done their best to enable him to do so.

The recognition and study of the consumer's claims in this respect is becoming more and more general, and it is safe to say that the attitude of most gas and electricity supply companies has not only already undergone a very pronounced change, but is likely to be modified even more in the future. Gas companies have in some instances offered the consumer exceptional facilities in this direction, undertaking the regular supervision and renewal of mantles, and attending to the adjustment of burners so as to secure the most perfect conditions of combustion —a matter in which he is occasionally insufficiently educated himself. The illuminating engineering movement in the United States has done much to bring about a more friendly spirit. We note in several of the electrical papers in that country an account of the efforts of the Boston Edison Electric Illuminating Company, of whose work we have previously made mention (*Illuminating Engineer*, Vol. I., p. 795).

To this company, it will be remembered, belongs the honour of being the first supply company actually to organize an expert staff of illuminating engineers, from whose advice company and consumer alike can benefit. When we first commented upon their action in this matter we ventured to predict that the efforts of Dr. Louis Bell and his staff would quickly meet with response, and that the Boston Edison Electric Illuminating Co. would reap the reward of their foresight and enterprise. A recent report of the results that have been achieved during the three months following the introduction of the Bureau, which we reproduce in abstract elsewhere, should already serve to justify this prediction. During this period no fewer than 450 applications for assistance were received and attended to, and it is very striking to observe that the services comprised in these statistics included nineteen churches. This would seem to indicate not only that there is a real demand for services of the kind referred to, but also that, as our special section in the last number was intended to show, the lighting of churches, where economy is often an important consideration, is a matter that would particularly repay close expert attention. It may also be remarked that simultaneous with the extension of their activity, the revenue of the company has not suffered, in spite of the very large sale of metallic filament lamps to the consumers ; and not only in Boston, but even from remote districts applications for expert advice and assistance were received.

The case quoted, however, is probably only a particularly striking example of the attitude that is now being taken up by companies for the supply of gas and electricity throughout the United States. It is significant that a very large number of the papers read before the National Commercial Gas Association at the annual meeting dealt with this subject. To some of these by Mr. C. W. Hare and others we gave attention in our last number. On this occasion we again reproduce in abstract some portions of a very complete paper by Mr. Willard, of the Rochester Gas Co., dealing with the same matter. In all these papers the necessity for fostering a friendly spirit between consumer and supply company was thoroughly appreciated.

Direct and Indirect Illumination

The relative merits of so-called indirect or inverted systems of lighting, in which the illumination is derived from a comparatively extensive light-giving surface, as compared with the ordinary direct systems, are now forming the subject of constant debate and are likely to continue to do so.

The recent extension of this system to lighting by tungsten lamps, for instance, has brought the matter into special prominence.

With one great advantage claimed by the inverted system—the exclusion of intrinsically over-bright sources from the field of view—most of those who have studied the subject would, one may suppose, now agree. Whether, however, the claim that the supposed resemblance to the diffused illumination of daylight is also entirely advantageous, would invariably be conceded, is open to question. On æsthetic grounds, many people are entirely averse to a monotonous general illumination, coupled with a complete absence of shadow, and even from the purely utilitarian aspect of the subject it has yet to be definitely shown that such a system is necessarily the best. It has also been suggested that the eye dislikes a uniformly bright illumination, craving dark surfaces on which to rest occasionally. For the moment we may perhaps endorse the cautious conclusion reached by Dr. Steinmetz in a recent lecture: "*In medio tutissimus ibis*,"—taking into account the special circumstances of each case.

In general, requirements are probably best met by providing a moderate general illumination, coupled with strong local treatment, in order to enable the attention to be more easily concentrated on specific objects. Among the few cases where total indirect illumination, and absolute absence of shadow appear desirable, Dr. Steinmetz mentions the drawing office. In other cases we may want more or less shadow, and probably in ordinary dwelling-room shadows that are not too sharp; on the other hand for the purpose of revealing very minute carving, &c., or for the study of surfaces, such as cloth of various kinds, one would be inclined to recommend the use of a source approaching the point, in order that the blurred edges of the shadows of small projections may not overlap and cause confusion.

Misleading Statements regarding Lighting.

This is again a subject on which we have had occasion to comment previously. The folly of putting in circulation misleading statements in support of one's own goods, or in depreciation of those of a competitor, is, we think, now very generally acknowledged, but it is naturally not to be expected that such a traditional, though evil practice, is to be obliterated in a day. Meanwhile, we observe frequent examples of the pot virtuously calling the kettle black, which possibly serves the utterer as a safety-valve, but naturally do not carry quite the necessary conviction.

It may be suggested, however, that the action of the makers of illuminating apparatus in Germany is one that deserves special commendation and might be followed with advantage

in this country. Recognizing, as they truly state, that the trades connected with illumination have suffered to a special degree from the circulation of misleading statements, representatives of manufactures of various types of illuminating apparatus have met together with the object of coming to an understanding on matters of mutual interest and co-operating with one another, in suppressing this and other evils. Although it only came into existence last year the union has not been inactive. Whatever the future of this organization, we recognize the benefit of mutual assistance of the kind embarked upon, and see in this movement but another illustration of the world-wide recognition of the need for a *rapprochement* between those representing different aspects of illumination.

The Old Need—An Independent Lighting Expert.

We observe that a recent rather important decision, with reference to extension of electric street-lighting, as opposed to gas, has given rise to free expressions of dissatisfaction on the part of the chief journals representing the gas industry. In some of the gas journals it is openly suggested, but not proved, that the case for gaslighting was not fairly considered on its merits, that the decision was biassed by outside considerations that ought not to have been allowed to influence it, and that the recommendation of the lighting committee, who, it is here urged, were in a position to judge the merits of the case, was deliberately set aside.

Although, on account of its importance, it has given rise to exceptional disappointment in many quarters, this is only one among many instances in which an adverse decision has been freely and bluntly criticized by those to whom it was unfavourable; to these we duly drew attention as being indicative of the dissatisfaction and confusion that must always prevail until there is available an independent and expert authority to whom such cases can be submitted, and whose decision would carry such weight as to be adjudged final.

The continual outbreaks of recrimination and the sense of injury that constantly follow decisions extremely adverse to those representing one or another system of illumination must convince those connected with all systems of the need for such an expert, if only in order that the party who considers himself injured may have some prospect of redress. We think that this is now becoming realized. When the suggestion of an impartial authority was first put forward there were some who failed to understand the nature of his functions, and therefore to realize his necessity. At the present day when, with increasing complexity and development, the competition between gas and electricity has become so crucial, the value of such an impartial tribunal becomes clearer than ever.

Naturally the existance of a sufficiently authoritative expert, or, as we should prefer, group of experts, can only be evolved gradually, and those who favour such a suggestion can only assist its fulfilment by bringing representatives of different systems of lighting in contact with one another and providing facilities for the study of illumination, as a subject, in its broadest sense.

We hope and believe that it is only necessary for those in authority to be brought to understand the magnitude of the issues now frequently involved, and the vital importance of treating the subject in a scientific manner, for this need to be recognized. In the recent decision of the City of London Corporation to appoint a deputation to visit the Continent for the purpose of studying methods of street-lighting (*Illuminating Engineer*, Vol. I., p. 904), we see evidence that leads us to hope that the justice of our contentions is becoming appreciated.

LEON GASTER.

Review of Contents of this Issue.

Mr. A. P. Trotter (p. 79) considers the RITCHIE PHOTOMETER in some detail, entering into the question of the correct angle that should be given to the wedge. In this connexion he describes some experiments on the reflection of light from unglazed white cardboard at different angles of inclination, and obtains a graphical relation connecting this angle and the reflecting power. Lastly, he describes several other attempts to utilize the Ritchie wedge for photometers, including the method of CONROY and that applied in the THOMPSON-STARLING INSTRUMENT.

Mr. J. Darch, F.S.I. (p. 83), contributes an article considering critically the different methods of SHADING NAKED LIGHTS in use, the materials of which such shades may be composed, and the objects that they ought to carry out, from the æsthetic and utilitarian aspects; the article is illustrated by numerous diagrams.

E. W. Weinbeer (p. 89) deals with the APPLICATION OF REFLECTORS with the object of MODIFYING THE NATURAL CURVES OF DISTRIBUTION of artificial illuminants, in any desired manner. He divides artificial illuminants into five chief classes, according to the general nature of the distribution of light from them, and gives a series of graphical constructions, enabling one to calculate the flux of light they must embrace in order to reflect any desired fraction of the total light downwards.

A paper by **Mr. J. R. Strong** (p. 98), read at the Annual Convention of the Illuminating Engineering Society, deals with some PRACTICAL DIFFICULTIES IN INSTALLATION WORK. Office-buildings are rarely so designed that alterations in the original scheme of illumination do not eventually become necessary, and Mr. Strong considers how it is possible, when designing the lighting scheme of such a building, to provide for all possible future emergencies without undue initial expense.

Dr. C. V. Drysdale (p. 101) continues the instalment of his series of articles dealing with the LAWS AND MEASUREMENT OF RADIATION. On the present occasion he gives some account of the Stefan-Boltzmann Law, illustrating his remarks by a diagram connecting the radiation from a black body with its temperature.

Mr. A. Cressy Morrison (p. 109) sends us a short article dealing with the merits of ACETYLENE LAMPS IN MINES. Such lamps, he contends, are specially suitable for this purpose, not only because they provide a better illumination, in comparison with oil, for a given amount of oxygen consumed, and thus assist ventilation, but also because they will burn in an exceptionally foul atmosphere; another point in their favour is the tenacity of the acetylene flame, in virtue of which it is not readily blown out by a gust of wind or draught.

An address by the same author (p. 120), delivered at a recent meeting of the Illuminating Engineering Society, deals generally with the connexion of the illuminating engineer with the gas profession, and also reviews the present state and possible future development of gaslighting, in which he professes to see a great field for future experiment.

The paper by **Mr. F. A. Willard** (p. 115) on 'SELLING GAS DURING DEPRESSION,' gives an account of the line of policy adopted by the Rochester Gas Co., U.S.A., during the recent financial crisis in the United States. The most interesting portion of the contribution, from the standpoint of illuminating engineering, is his account of the methods of dealing with consumers, of registering and attending to their various complaints, and the system of free inspection and assistance adopted by this company.

Another article on p. 123 deals with a somewhat similar subject, namely, the report of the progress of the ILLUMINATING ENGINEERING DEPARTMENT established by the BOSTON EDISON ELECTRIC ILLUMINATING CO., under the supervision of Dr. Louis Bell, for the benefit of their consumers.

The object of this bureau is to offer free assistance and expert advice to the consumer in arranging his lights to the best advantage, and the company itself also supplies the required lamps, &c. It is stated that during the three months for which the bureau has been in existence it has amply justified its creation, and led to a great increase in business. This electric supply company is believed to be the first actually to organize a bureau of expert illuminating engineering for the benefit of their customers.

Among other articles in this number mention may be made of the communication on p. 103, containing an account of a series of TESTS ON CARBON FILAMENT LAMPS RUN AT HIGHER VOLTAGES than those for which they were originally intended, thus leading to a certain shortening in life but a corresponding gain in illuminating efficiency.

On p. 78 occurs an historical survey of LIGHTING IN LONDON DURING THE SEVENTEENTH AND EIGHTEENTH CENTURIES, chiefly concerned with the various regulations that were put in force relating to the hanging of suitable oil-lamps outside their doors by householders within certain hours. At one time this constituted the first and only attempt at street-lighting. Subsequently the monopoly of providing such illumination was given to certain individuals, but it was only with the introduction of gas and electricity that a serious attempt to illuminate the streets of London was made, and previous to this time it was regarded as a very unsafe and perilous thing to do to venture into them by night.

Some other articles (p. 94) deal with the methods of using LIGHT FOR PURPOSES OF SPECTACULAR DISPLAY in certain New York restaurants, and the DESIGN OF FIXTURES (p. 111). In the latter article it is pointed out that certain of the usual methods of suspending heavy glass shades, &c., by the mere rings on the lamp-holder, are open to criticism, a separate support, quite independent from the lamp-holder, being considered preferable. It is also suggested that æsthetic considerations demand an obviously fairly substantial support for a fixture that is intended to be heavy in appearance.

Among other shorter notes attention may be drawn to some particulars of a FORM OF SHADOW-PHOTOMETER introduced in Germany (p. 127), a reference to some developments and applications of HOLOPHANE SHADES (p. 126), and a brief abstract of an article by **Mr. J. S. Dow** on the MECHANICAL EQUIVALENT OF LIGHT (p. 130).

There is an exceptional amount of correspondence in the present number. **Mr. A. J. Marshall** writes on the subject of ILLUMINATING ENGINEERING QUALIFICATIONS, urging not only the need for any illuminating engineer, in the proper sense of the word, to make himself acquainted with all the various aspects of the subject, including those of the architect and physiologist, but also constantly to modify his theoretical views by the hard rules of practical experience.

Dr. B. Monasch and **Prof. L. Weber** (pp. 133–4) contribute some remarks on the subject of the relative merits of the terms LUX AND METERKERZE, to denote the unit of intensity of illumination ; and **Sir Wm. Preece** (p. 135) sends us some account of his early work in this field, explaining the basis of the definition of the suggested term "lux" as then put forward, in terms of the French "bec" standard.

Mr. Leonard Stokes (p. 136) and another correspondent contribute some discussion of the articles on CHURCH-LIGHTING in our last number. Mr. Stokes contends that illumination in churches ought to be adapted solely to the needs of the congregation, and ought not to be regarded as for the purpose of beautifying the interior, which, from the architect's standpoint, can only be done satisfactorily by daylight. Our other anonymous correspondent dwells on the symbolic and religious significance of light from the earliest times, which, he suggests, renders the application of modern sources unsuitable.

At the end of this number will also be found the usual **Review of the Technical Press** (p. 139) and the **Patent List** (p. 143).

TECHNICAL SECTION.

[*The Editor, while not soliciting contributions, is willing to consider the publication of original articles submitted to him, or letters intended for inclusion in the correspondence columns of 'The Illuminating Engineer.'*

The Editor does not necessarily identify himself with the opinions expressed by his contributors.]

Illumination, Its Distribution and Measurement.

By A. P. Trotter,

Electrical Adviser to the Board of Trade.

(*Continued from p.* 9.)

The Angle of the Ritchie Wedge.—Nobody (except for the purpose of criticizing the principle*) has ever suggested that the angle of a Ritchie wedge should be greater than 90 degrees. The Conroy modification, which will be described later, is equivalent to a wedge having an angle of 60 degrees. The Thompson-Starling photometer consisted of two cards meeting at 70 degrees. It is obvious to any one who is even vaguely acquainted with Lambert's cosine law, that if a wedge shaped like 1 in Fig. 57

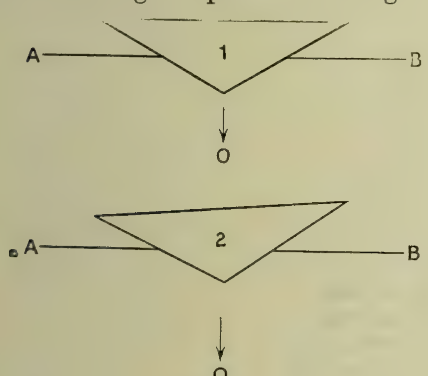

Fig. 57.

is shifted by carelessness or by bad workmanship, into the position shown at 2, the side illuminated by the light B will be much brighter than the side illuminated by the light A. But apart from any such error, the angle is clearly a bad one, for the illumination of the sides is much less than it need be. If we go to the other extreme, and use a wedge with a small angle, as in Fig. 58, it is true that the sides are illuminated almost as brightly as possible, but very little is to be seen of them, and the law of diffused reflection of light from unpolished surfaces, discovered by Bouguer, shows that the brilliance will be actually less than if a more blunt angle is used. For most substances an angle of about 70 degrees for the wedge is best. A slight displacement of the wedge, or want of alignment of the lights, causes no appreciable error. For while

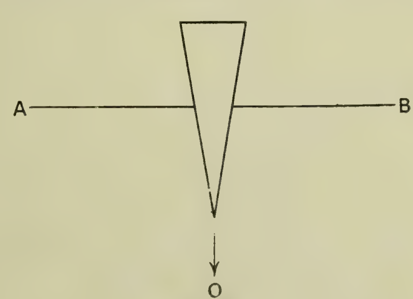

Fig. 58.

the illumination of one side is diminished and the other increased, according to the cosine, the intrinsic brilliance of each is altered in the opposite sense.

In developing my own modification of the Ritchie wedge, which consists of viewing one inclined card through a hole cut in another, I made some experiments to determine the best angle. Fig. 59 shows how the experiment might have been done, though in fact it was carried out in a somewhat different manner. The light A illumines a screen at a fixed angle of inci-

* Lancelot W. Wild, *The Electrician*, July 20, 1906.

dence of, say, 30 degrees. Another screen, capable of angular movement, is illuminated by the light B. The figures indicate the angles of incidence. At angle 60 degrees the screen is considerably inclined to the light B, and in order to balance the illumination of the fixed screen this light must be brought close to it. Move the screen to angle 40 degrees, and the illumination is increased about 53 per cent (the ratio of cos. 40 degrees to cos. 60 degrees) and the light B must be moved away in order to get a balance with the screen. The apparent brilliance as seen in the direction O is also greater, but if the screen is moved to angle 20 degrees, while the illumination is still further increased to about 23 per cent more than at angle 40 degrees, the brilliance is less, because the screen is incapable of reflecting the full proportion of light at so oblique an angle.

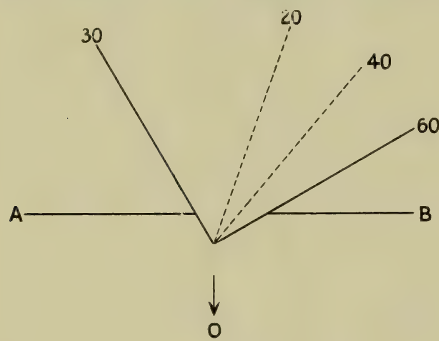

Fig. 59.

This relation between the apparent brilliance and the angle of the screen may be represented by a polar curve, but unless some simple trigonometrical function governs a relation, it is often better to use rectangular co-ordinates. Fig. 60 gives the curves for several different substances. (I regret that I have lost the original readings, and can only reproduce the curves from a rather blotted copy in a letter-book. Curves thus plotted from experiment should always show the observed points, and this I am unable to do until I have an opportunity of repeating the work.) The substance giving the greatest brilliance due to true diffused reflection was white blotting-paper. The maximum was about 18·2 arbitrary units at an angle of incidence of about 27 degrees. At 22 degrees and at 33 degrees it was 18.*

At 5 degrees—that is, when the screen was turned nearly full to the light, but showed very little to the observer—the brilliance was 15·6, and the brilliance was of about the same value when the screen was moved through 45 degrees to make an angle of incidence of 50. Turning it through another 15 degrees, making an angle of 65 degrees, reduced the brilliance to 8·5.

Ordinary white Bristol board, having a glazed surface, behaves very differently, due to the regular or specular reflection of the glaze. The specimen, though of the best quality, was not so brilliant as the white blotting-paper, until the angle of incidence was 35. At this angle, regular reflection had begun to show, and the brilliance increased rapidly as 45 degrees was approached. A maximum of nearly 22 was reached, and with greater angles the brilliance fell off, remaining higher than that of the blotting-paper. The same kind of card, lightly rubbed with pumice flour to remove the glaze, behaved very much as the blotting-

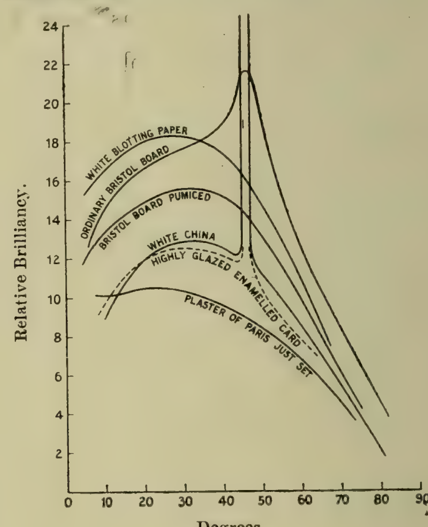

Fig. 60.

* When the two screens were made of exactly the same material, and fixed at the same angle, and equal lamps were placed at equal distances on each side, the brilliance was of course the same. One screen and its lamp was fixed, and the brilliance was taken as 10 units.

paper, the brilliance being from 18 to 10 per cent less. With a piece of white china it was evident that the reflection was of two distinct kinds. It behaved like the blotting-paper or pumiced Bristol board until 45 degrees was reached. At about that angle (and over a small angle on either side, corresponding with the apparent angular magnitude of the lamp which illuminated it), the brilliance flashed up to a point far beyond anything that could be measured in this manner. Highly glazed enamelled white card behaved in the same way. These curves show that the regular reflection of Bristol board and such materials extends over a considerable angle, but that so long as care is

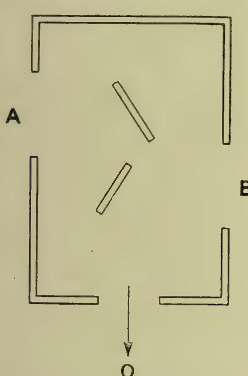

FIG. 61.—Conroy's Photometer.

taken to avoid the angle of regular reflection, a highly polished white surface may be used in place of an unpolished one, and it may be said that no unpolished surface is so unpolished as a highly polished one except at the particular angle at which the polish is appreciable.

The historical order of photometers will be dropped now, and a few modifications of the Ritchie wedge will be described. It will be remembered that Bouguer found that the two illuminated surfaces "cannot be too close together....and it would be a good thing if possible to make their edges touch each other."* That has been the aim of several inventors.

The Conroy Photometer.—Taking this instrument in the historical order of date of publication (April 28th, 1883)* we find it to be a modification of the Ritchie wedge. The inventor says that the accuracy of the determination in shadow photometers depends on the edge of the shadows coinciding and yet not overlapping: the Ritchie photometer when constructed by bending a piece of paper round a wooden wedge gives an imperfect junction. He used two pieces of paper 3 cm. by 3 cm., held by india-rubber bands on blocks of wood. (In Fig. **61** the blocks of wood are not shown.) One piece of paper overlaps the other, as seen from direction O. He proposed that in order to avoid regular or specular

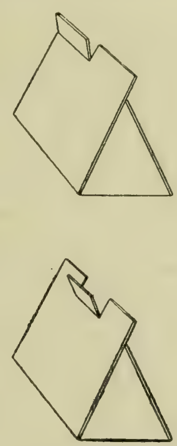

FIG. 62.—Thompson & Starling's Photometer.

reflection, the angle of incidence of the light on the paper should be 30 degrees, and that the line of light should make 60 degrees with the normal to the paper. "It is of course essential that the light should be incident upon both papers at equal angles, and that the papers should be so placed that no light can be reflected from one to the other."

The Thompson-Starling Photometer.—Though designed and used in 1881, this modification of the Ritchie wedge does not appear to have been published until June 9th, 1893. It consists of a wedge in which the two surfaces meet at an angle of about 70 degrees. Prof. Silvanus Thomp-

* *Illuminating Engineer*, Vol. I., 1908, p. 800.

* Sir John Conroy, *Phil. Mag.*, Vol. xv., p. 423.

son says, "When working with this photometer it was found that the precision of judgment of the eye as to equality of the two illuminations was impaired, if by bad workmanship any considerable width of blunted edge intervened between the two surfaces that should have met with precision. The principle of overlap and a sharp-cut edge, as afterwards adopted by Sir John Conroy, is used, and "he found," writes Prof. Silvanus Thompson, "as I did, that 90 degrees is too large a dihedral angle for exact work. Materials such as card and paper are never entirely devoid of specular reflection." Fig. 62 shows two forms of overlap.

(*To be continued.*)

The Need for Good Illumination in Modern Education.

A SPECIAL claim may be made for good illumination bearing in mind the conditions under which modern instruction tends more and more to be carried out.

In ancient times knowledge was communicated almost entirely orally —was transmitted from generation to generation, &c., by word of mouth.

Subsequently the arts of writing and printing not only enabled knowledge to be accumulated in a manner impossible before, but provided a very valuable method of communication in addition.

The tendency to replace oral by graphic instruction is still progressing. It has even been claimed that the enormous spread of printed matter, and the development of books and magazines of all descriptions, is having the effect of relegating conversation to the "lost arts."

However this may be, there can be no question that there is ground for believing the tendency to be operative in teaching. Many people will admit that they are able to learn a subject both easier and quicker by the aid of a text-book than by means of lectures. Certainly it stands to reason that a *writer*, by careful thought, ought to be able to frame a more lucid explanation than a speaker on the spur of the moment—especially as his delivery, unlike a standard printed type, is not infrequently defective in some respect.

The organization of lecture experiments, the use of the blackboard and diagrams, and, more recently, the application of such instruments as the cinematograph and the oscillograph to teaching purposes, are all examples of the same tendency.

The moral to be drawn from the foregoing is obvious.

For general physiological reasons there is every reason to advocate a good illumination in schoolrooms and lecture theatres, But when it is realized that the *eye* is being relied upon to an ever-increasing extent as a means of training the mind, the necessity for good lighting, in order to enable the eye to perform its functions with ease and comfort, becomes more vital than ever.

Memorial to Sir George Livesey.

WITH reference to the steps it has been decided to take to perpetuate the memory of the late Sir George Livesey, the committee having the matter in hand desire to announce that contributions to the fund should be sent to the Secretary of the Institution of Gas Engineers, 39, Victoria Street, Westminster. A sum of at least £10,000 is required for the object in view—the endowment of a Livesey Professorship in Gas Engineering and Fuel at the Leeds University—and contributions both small and large will be welcomed.

Having regard to the great services which Sir George Livesey rendered the industrial world, and indeed to all classes of the community, it is felt that there will be a general desire throughout the country to do honour to his memory.

The Art of Shading.

By John Darch, F.S.I., Mem.R.San.Inst.

The art of shading consists in the adoption and adaptation of shades so constructed that complete protection shall be given to the eyes without the necessity of depriving the room of more than a modicum of the initial flux of light. The purpose in shading is to obtain increased visibility, better illumination, and economy in light energy. In dealing with this subject the employment of transparencies as shades will be considered to be irrational, and the use of glass enclosures to lights, wasteful and usually unnecessary.

Shading, to be worthy of the name, should be effectual. The root meaning of the expression "to shade" is to screen, to intercept, or to protect by interposition. The idea is as old as man himself, to whom a promise "that the sun shall not smite thee by day" was the reflex of his susceptibility to injury. In his most untutored days he never sought cover in a glasshouse, but fled to "the shadow of a great rock." The modern artificial illuminant is as liable to "smite" as the summer sun; the word "shade," therefore, is to be used in the same sense of full and complete protection. The term is correctly applied to a transparency when it is employed to shield an ornament from dust, but it is obviously a misnomer when such transparencies are applied to light; they can neither conceal the light nor defend the subject from its mischievous attacks. Transparencies could, quite consistently, be dismissed as being outside the subject of shading, but being so extensively used as "shades" it becomes necessary to inquire into their practical value.

There are two extremes in lighting to be avoided—insufficiency and excess. The modern tendency to the use of high power illuminants will amend the former, and it is the function of shading to modify and cover the latter, but without destroying the advantages of the greater light. If it were not a question of cost one could hardly have too much light, for the wider the margin left for modification by shades and diffusers the greater the possibilities of success. It is the superabundance of light that makes daylight so satisfactory; atmosphere and cloud reduce the intensity of the sun from an estimated 600,000 candle-power per square inch to the more tolerable sky brightness of 2 to 5 candle-power. This would appear to be an enormous waste; probably so—it is Nature's way—but ample remains, and our needs are exactly met. Why this degree of brightness in Nature's diffusion is tolerable when a much lower degree in a translucent diffusing shade is intolerable, is not fully explained, unless it be attributable to the strong contrasts of darkness and concentrated light which characterize artificial lighting. Just as the ill effects of draught are due to the unequal cooling of the body by the same wind that would be harmless in the open, so a spot of light on one portion of the retina, otherwise comparatively dark, is more irritating than the entire flooding of the eye with a much stronger light per unit of area. That it is not so much the character as the distribution of the light that offends is demonstrated by the dazzling effect of daylight through a small aperture in the upper part of a dark cell when in contrast with the adjacent gloom. Daylight, under such circumstances, would need shading and diffusion equally with artificial light.

The question of the capacity and endurance of the eye cannot be discussed here, but it is suggested that a surface intensity of ·05 candle-power per square inch or 7 candle-power per square foot should be the maximum brightness from any point or surface,

reflected or transmitted, that should be permitted to persistently stare one in the face.

Shades, as commonly known by that term, may be classified as follows :—

1. Transparencies : enclosures or screens of glass, clear, tinted, or so lightly figured as to leave the source of light visible.
2. Translucencies and diffusers : ground, iced, opaline, and prismatic glass or other highly translucent material.
3. Shades proper. These may be divided into two classes : (*a*) Semi-opaque : of little lighting value, but passing sufficient light for decorative purposes ; (*b*) opaque screens.

Class 1.—Probably every reader will agree that a transparent globe, bell or screen of glass, whether it be clear, tinted, opalized, etched, figured, satin finished, or cut, must be valueless as a shade if little or no modification or diffusion of the light is effected ; and it can but be injurious to the eyes of those who seek to find something "pretty" in it. Let any one examine the stock of glassware of any electrical or gasfitting manufacturer, and he will find that probably the bulk of the stock will consist of shades that come within this class. Clear glass enclosures—and the clearer the better —may be used to lights placed out of the range of ordinary vision, where rendered necessary for some collateral or incidental reason, otherwise they are better away. Transparencies are also quite in place when employed as beacons, signals, or for some alluring display of a pyrotechnic character, in which the lights are required to be displayed for their own sakes.

Class 2.—It is to the development of translucent and diffusing glass that the efforts of shade makers have been principally directed. The object aimed at is the distribution of the intrinsic light over the larger area of an enclosing globe or bell. This is necessarily accompanied by a loss in absorption proportionate to the density of the glass. Although not a true shade it is a step —a small one—in the right direction. The shapes, sizes, qualities, and characteristics of this class are legion. Few shade-makers have gone beyond it. Perhaps the opal globe is the most successful in securing an equable distribution of the light over its surface ; it is, however, at a sacrifice of 50 per cent or more of the light. The ground or frosted glass is less wasteful, but equally less beneficial. Nearly every other form of icing, roughing, embossing, etching, and cutting fails, more or less, to obtain anything like perfect diffusion, while some intensify the difficulty by collecting the light in spots and streaks. Prismatic glass formed into globes, bowls, bells, &c., has been introduced, with the combined object of distributing the light over the full area of the glass, of limiting the waste in absorption, and of directing the bulk of the light in certain directions ; it is, perhaps, the most successful of the class. The light may be directed horizontally—to the discomfiture of those in the line of its rays—and downwards, seldom upwards.

Unfortunately all translucent "shades" fall short of the ideal, for the reason that the area of distribution is not commensurate with the requirements. Take, for example, a 32 candle-power light in an 8 in. globe. Assuming perfect distribution and an absorption of 15 per cent, the result would be a surface brightness of ·5 candle-power per inch—ten times the aforesaid tolerable maximum. It would take a 25-in. globe with perfect diffusion to reduce the surface intensity to ·05 candle-power per square inch.

As to economy of light energy, it has been shown that as a shade, the glass diffuser is ineffective. It is now proposed to show that it is a needless darkener and wasteful. The clearest glass will absorb 5 per cent of light ; and other kinds, anything up to 60 per cent.

What is it that is to be protected when a shade is placed around a light ? Surely the eyes and the eyes only. It must be evident, therefore, that unless one climbs a chair or sits on the floor the serviceable area of an average shade is very small ; and that in covering up the whole of the light the engineer is unnecessarily darkening

the ceiling and walls—the best media of general lighting, and those that contribute better than any others to the pleasing character of a well-lighted

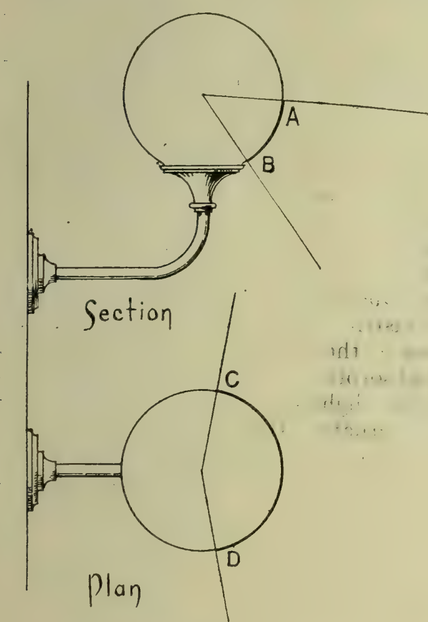

FIG. 1.

room. To illustrate this: let Fig. 1 represent the plan and section respectively of an 8-in. spherical shade, having a surface of about 200 square

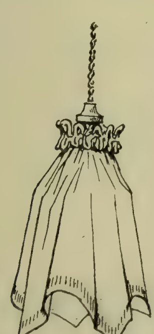

FIG. 2.

inches, and let the centre be about 6 ft. 6 in. from the floor, and the shade fixed upon a bracket in an ordinary room. Then AB will represent the limit of height and CD the horizontal width of that portion of the globe which is employed in screening the eyes, and which will amount to about 30 square inches. Now, light is to be sought and enjoyed, not destroyed, and yet for the sake of the necessary 30 inches the whole 200 inches of light is sacrificed.

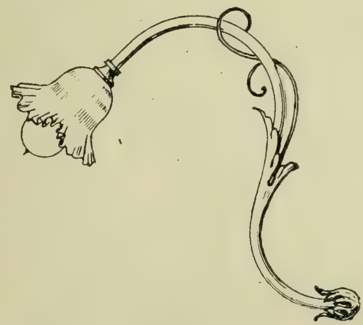

FIG. 3.

This waste is even more striking where textile and other such like shades are used, because the percentage of transmitted light is lower. The form of shade shown in Fig. 2 reminds one of the old inquiry, " Is a candle brought to be put under a bushel ? " Shades of similar interest are to be found in all directions, particularly where colour and gloom preside.

There is, however, something to be said in favour of these shades, for they do modify the light, however wastefully ; but what can be said of the most popular form of shades, particu-

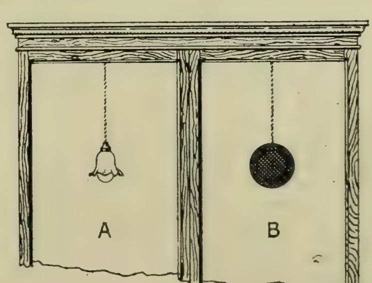

FIG. 4.

larly when placed upon the most popular form of bracket and chandelier arm, shown in Fig. 3 ; and who can say what it is supposed to shade ?

Class 3.—Opaque shades: If there be any standard examples of good lighting they are to be found in the stage of the modern theatre—about the only subject that has received intelligent and adequate consideration.

Its methods are strongly commended, for therein will be found all the elements of good lighting—equality of distribution, strong diffusion with a predominating direction, soft shadows, and easy discernment. It is by no means impossible to obtain similar results in our living rooms, churches, shops, and all places needing illumination. The conditions are: (*a*) as much initial light as is obtainable; (*b*) adequate or complete screening of the light from the eyes, but no more, beyond which (*c*) the room to be fully and directly illuminated, without the intervention of glass. The room will then have the full benefit of reflection from the large area of ceilings and walls, producing a general pleasing effect with the predominant downward direction so necessary to an exact appreciation of the objects to be seen.

This method of shading and illumination is suited, practically, to nearly every case; there may be some in which it is less easy and convenient, but there are others to which it is singularly well adapted. An early example of the latter occurred in some show-cases, in which the electrician, after several changes of positions and "shades," failed to satisfy the client, and left the lights, as shown at A, Fig. 4. The remedy was ludicrous in its simplicity and cheapness: an opaque advertising disc was placed on the plate glass in front of the light, and the contents of the cases were at once shown up. In another case a short curtain met the difficulty. This might appear obvious to any one, but three out of four of the shop fronts in London at the present day would profit by some such humble remedy.

(*To be continued.*)

Union of Those Engaged in the Illumination Industry.

An interesting illustration of the movement towards co-operation on the part of those representing different sections of what may be now termed the "illumination industry," is afforded by the formation of the "Verband der Beleuchtungsgeschäfte" in Berlin, in 1907, representing the various trades connected with lighting and illumination. An account of the year's progress of this union is given in a recent number of the *Zeitschrift für Beleuchtungswesen.*

During the year six ordinary meetings have been held, and in addition a number of extraordinary ones, and meetings of committees, &c. One subject that came up for discussion was the selling of goods by firms retail, and it was decided that this action should be, as far as possible, put a stop to.

Attention was also bestowed on the publication, on the part of some firms, of incorrect and prejudiced statements concerning their wares, calculated to deceive the public. In this respect the illumination industry had suffered to a marked degree. It was agreed that pressure should be brought to bear on offenders in order to repress this evil.

The reference to the doings of the union, from which we quote these items, concludes with the exalted declaration that "only honourable and persevering industry and energy are rewarded in this life."

Some Notes on the Historical Development of Street Lighting in London in the Seventeenth and Eighteenth Century.

By a Correspondent.

The history of the illumination of London's streets has yet to be written. To unravel the tangled threads, and to bring the dispersed elements involved in such a history into a clear and systematic narrative, is no easy task. In spite of the works of Stowe, Maitland, Seymour, Macaulay, Lecky, Walter Besant, &c., who occasionally have referred to this matter, and who may claim the distinction of pioneers, there still remain large tracts of untraversed territory, in the exploration of which the scholar has available but meagre data. The following remarks are only intended as a preliminary and general survey of the lighting in London, chiefly in the seventeenth and eighteenth centuries, and mainly derived from the labours of the before mentioned investigators.

It is curious in our own days of gas-light and electricity to look back to those times, when

"it was a common practice in this city that a hundred or more in a company, young and old, would make nightly invasions upon houses of the wealthy to the intent to rob them and that when night was come no man durst adventure to walk in the streets."

It was an age of lawlessness, when only a candle with a cotton-wick was suspended here and there from six to eleven o'clock on dark nights; it was a time of lanthorns, flambeaux, and linkboys, when everybody signed his will and was prepared for death before he left his home. Forgotten were the bonfires on May Day and Midsummer Eve of Henry VIII., when the streets were full of light, when, over the doorways of the houses, oil-lamps actually burned all the night through.

In 1415 the first attempt at regular lighting of the streets of London was made when the Mayor, Sir Henry Burton, ordered householders to hang out lanthorns in the winter evenings betwixt Allhallows and Candlemas (*i.e.* the festive season).

For three hundred years afterwards the citizens of London were, from time to time, reminded, on pains and penalties, to hang out their lanthorns at the appointed time; for, after curfew, the town appeared practically lifeless. For the securing of houses against robbers and thieves, for the prevention of murder and the convenience of passengers, the watchman with his long coat, halberd in hand, and lanthorn, passed the street crying out:—

A light here, maids, hang out your lights,
And see your horns be clear and bright,
That so your candle clear may shine,
Continuing from six till nine;
That honest men that walk along
May see to pass safe without wrong.

In 1668 all inhabitants of London were ordered "for the safety and peace of the city to hang out candles duly to the accustomed hour." In 1679 the Lord Mayor proclaimed among other things: "....the neglect of the inhabitants of this city in hanging and keeping out their lights at the accustomed hours, according to the good and ancient usage of this City and acts of Common Council on that behalf." But still "when nights darkened the streets then wandered forth the sons of Belial, flown with insolence and wine," and so the Act of 1676 was renewed in 1690. Every housekeeper had to place a candle or a light, on moonless nights, from Michaelmas to Lady Day, "excepting such person or persons as shall agree to make use of lamps of any sort, to place at such distances in the street, as shall be approved of by the justices of peace."

It ought to be remarked that at that time an ingenious projector, named Edward Heming, obtained letters Patent conveying to him, for a term of years, the exclusive rights of lighting up London. He undertook, for a moderate consideration, to place light before every tenth door, from Michaelmas to Lady Day, and from six to twelve o'clock. Although Heming's

lanthorns glimmered feebly, he really had done a good deal to illuminate and guard the city, and to banish nocturnal shadows. Nevertheless his contemporaries attacked him furiously, and the licence granted in 1694 to certain persons "concerned and interested in glass-lights, commonly called or known by the name of convex-lights" was withdrawn in 1716.

The city had again many districts, where no light was to be seen. In 1716 every housekeeper whose house fronted any street or lane and was rented at 10*l.*, and every person having the charge of a public building, was required and obliged, on penalty of a fine of one shilling, during every dark night, from September 29 until March 25, to hang out one or more lanthorn or lanthorns with sufficient wick-candles lighted therein, and to continue the same burning in every such dark night, from the hour of six until the hour of eleven o'clock of the same night.

This method of lighting the streets at night was soon found to be very inadequate and insufficient, because (1) most of the inhabitants were not rated up to 10*l.*, and (2) the limited period of time during which the streets were lighted were found to expose the citizens to the depredations of street-robbers and housebreakers. After eleven o'clock the City was practically in total darkness. The shops, which were kept open till eight or nine o'clock, in the evening, alone made the streets agreeable for these few hours, so that Defoe in 1729 published a pamphlet wherein he demonstrated his plan, according to which our streets were to be so *strongly guarded* and so gloriously illuminated, that any part of London would be as safe and pleasant at midnight as at noonday, and burglary totally unpracticable.

Up to 1736 the lighting was done by contract, and the contractors, by a singular arrangement, agreed to pay the City 600*l.* a year for their monopoly. In return for this they were empowered to levy a rate of 6*s.* a year upon all housekeepers who paid poor rates, and from all who had houses of over 10*l.* per annum, unless they hung out a lanthorn or a candle before their doors (see above).

As this private undertaking became a good job for the contractors, and the robberies increased in 1736, it was thought needful to apply to Parliament for powers to light the streets in a more effectual manner, and to take the lighting of the City out of private hands. An Act was accordingly passed, by which the City was empowered to put up lamps where they might think fit, to burn from sunset to sunrise. And to bear the expense of this lighting a rate was imposed of 7*s.* on every house under the rent of 10*l.* per annum; of 10*s.* to 20*s.* on houses at 12*l.* per annum; of 20*s.* to 30*s.* on houses at 14*l.* per annum; of 30*s.* to 40*s.* on those at 16*l.*; and not more than 40*s.* on houses of a higher rental. Instead, therefore, of a thousand lamps, the number was now increased to 4,679; but as these even were not sufficient, several of the wards made a considerable increase, so that the whole could amount to no less than 5,000.

This, however, was only the amount in the "City and Liberties," and does not include the suburbs. In 1738 it was estimated that the whole number of lamps was about 15,000. The time of lighting also, which before had been only 750 hours annually, was increased to 5,000. In 1739 and 1744 this Act was enlarged, and made more stringent owing to the great number of robberies committed in the streets during the night. I mention "the officious link-boy's smoky light," and the dim light of the theatres and taverns, and turn again to street lights.

The age of lamps were approaching. The City made another and more important step in 1762. In that year the Westminster Paving and Lighting Act was passed. The days of the lamp-lighters began (see Hogarth's wonderful picture, 'Rake's Progress') with the tin vessel containing oil, till also this feeble glimmering light was superseded by the introduction of gas, first adopted in London's streets in 1807. DR. B. S.

(*To be continued.*)

On the Use of Reflectors for the Purpose of Modifying Intensity of Illumination.

By E. W. Weinbeer.

A short time ago the author published an article in the *Elektrotechnischer Anzeiger** with the object of showing that the polar curves of distribution of light of all ordinary illuminants could be classified according to shape into several distinct groups.

In this classification the alternating current arc with vertical carbons was alone left out of account, but at the present time this particular source is not of very great consequence. The actual polar curves of distribution of light may also be replaced by other simpler curves which approximate to them in shape, and are more easily treated mathematically. Such curves are shown in Fig. 1.

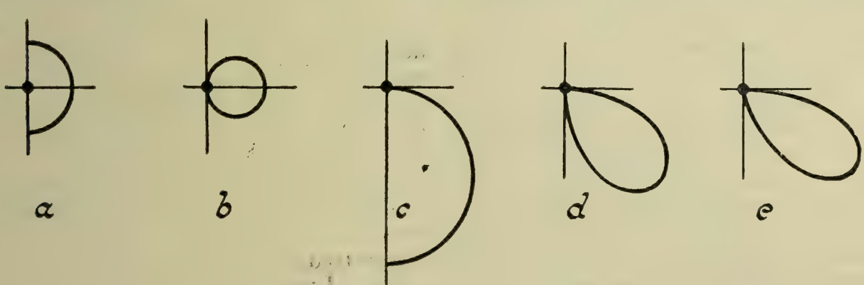

Fig. 1.

The actual mathematical expressions corresponding to the above curves are as follows :—

Fig. 1_a, $I = \text{constant}$.
,, 1_b, $I = \text{constant} \times \sin \phi$.
,, 1_c, $I = \text{constant} \times \cos \phi$.
,, 1_d, $I = \text{constant} \times \sin 2\phi$.
,, 1_e, $I = \text{constant} \times \sin 2\phi . \sin \phi$.

The values of the constants in 1_b, 1_c, 1_d, and 1_e are I_{90} (horizontal intensity), I_0 (vertical intensity), I_{45} (intensity at angle of 45 degrees), and I_e (approximately 1.3 times the intensity emitted at an angle of slightly less than 55 degrees in the lower hemisphere).

Group 1_a is merely of theoretical interest, for there is no practical source of light which emits light of the same intensity in all directions. The inverted incandescent mantle, however, yields a very nearly uniform intensity over the lower hemisphere.

To group 1_b belong the electric glow-lamp and the upright incandescent mantle, &c. ; to group 1_c the high candle-power flame arc-lamps with inclined carbons ; while D.C. arc-lamps with vertical carbons fall into the groups 1_c and 1_d.

In a subsequent article in the *Elektrotechnische Anzeiger** the writer has also described a method of designing reflectors so as to secure, subject to certain limitations, a uniform horizontal illumination, under any desired conditions ; and, in a third article in the same journal, proposes to explain how this method may be replaced by a purely graphical one.†

The object of the present article is to determine what portion of the total amount of light emitted by a certain source of light can be utilized

* *Elek. Anz.*, 1907, No. 66.

* *Elek. Anz.*, 1908, Nos. 41 and 43.

† *Elek. Anz.*, 1908, No. 62.

for the purpose of horizontal illumination, bearing in mind the extent of the surface of the reflector, and the nature of the reflecting surface involving a coefficient of absorption, which, we may term "α." In what follows, all angles are measured with respect to the portion of a vertical line drawn through the source of light in question, above the zero abscissa. According to this system the downward vertical intensity, for instance, becomes I_{180}.

The device employed, as illustrated by Figs. 2–6, is very simple, and depends to obtain the total flux of light over the lower hemisphere, and thence the mean hemispherical candle-power.

The construction shown in Figs. 2 to 6 enables us to calculate what fraction of the total flux emitted by a source must be enclosed by the reflector in order to reflect any specified proportion of, say, from 0 to 50 per cent of the total light downwards. The extent of this angle will naturally depend upon the value of the coefficient of absorption, α, of the reflector.

Figs. 2 to 6 exhibit the construction

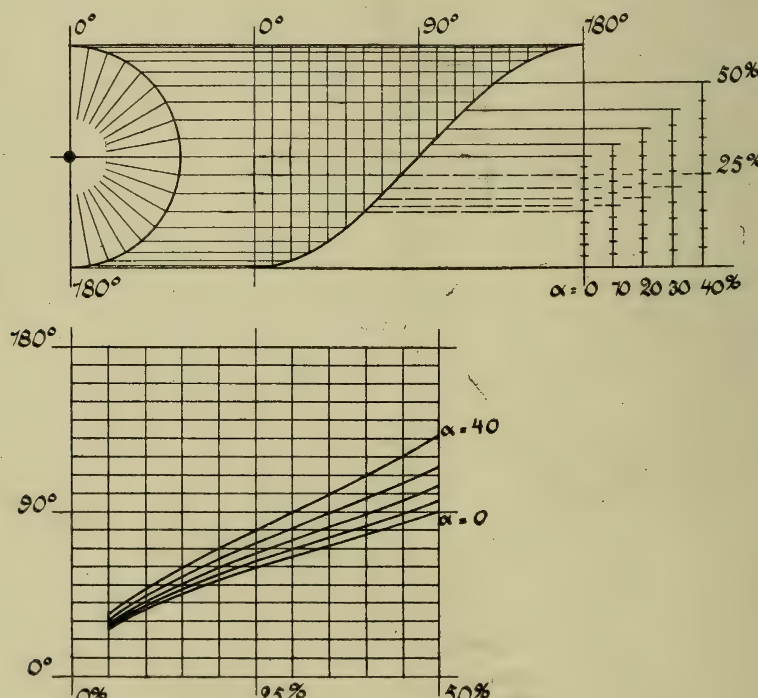

Fig. 2 (corresponding to Fig. 1a).

upon Kenelly's method* of obtaining the curve of a flux by light between the angles ϕ_1 and ϕ_2, namely, 2π I (cos. ϕ_1—cos. ϕ_2).† The exact method due to Kenelly, though very ingenious, is too tedious and complicated for the present purpose, and in the diagrams above referred to we obtain the quantities 2π I (cos. ϕ_1—cos. ϕ_2), &c., directly by vertical projection, afterwards pricking off along a straight line so as as it will appear in the case of each of the types of curves shown in Figs. 1a, 1b, &c. They are all drawn to the same scale, and are, therefore, mutually comparable one with another, all corresponding with the same total flux of light. The abscissa, 0 degree to 180 degrees, or 90 degrees to 180 degrees, as the case may be, represents angular regions of flux. The vertical elements, projected from the polar curve and shown in thick lines, are each proportional to 2π I. (cos. ϕ_1—cos. ϕ_2), *i.e.*, to the

* *Elec. World*, N.Y., 1908., No. 13.

† *Illum. Engineer*, London, 1908, No. 7.

flux between these angles, and hence their addition, as represented by the ordinates of the diagram, will in each case stand for the total flux enclosed between any range of angle. Thus in Figs. 2 and 3 the diagram makes it clear that between 90 degrees and 180 degrees, or between 90 degrees and 0 degree, 50 per cent of the total flux of light is enclosed.

In order to determine, therefore, what fraction of the total flux of light must be enclosed by the reflector having plotted connecting the values of a and the corresponding angular fluxes of light that will need to be enclosed by the reflector in order to secure any desired result. It may be noted that in some cases all the available light falls below the horizontal, and there is therefore no object in allowing the reflector to enclose the region 0 degrees to 90 degrees. It may also be mentioned that the method is equally applicable to polar curves of all varieties. It is only for convenience that curves

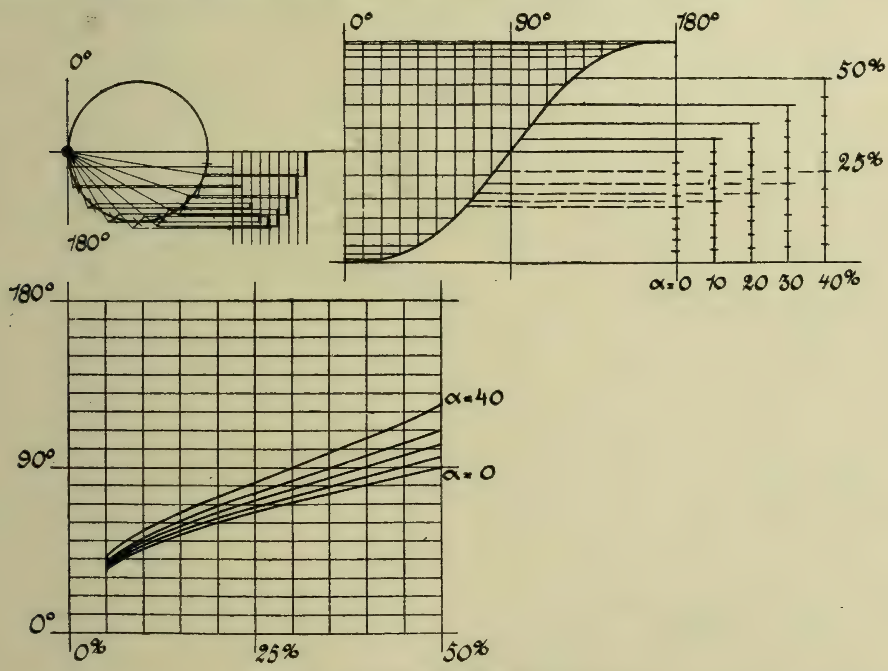

FIG. 3 (corresponding with Fig. 1 b).

a given coefficient of absorption, so as to throw down any specified part of the total light varying from 0 to 50 per cent, we need only increase the value of our ordinate by an amount proportional to the loss of light by absorption, project across horizontally, and observe the angle at which this horizontal cuts the curve. In each figure this horizontal line is drawn for values of $a=0$, 10, 20, 30, and 40 per cent respectively. Beneath the main construction a series of curves are of the five main varieties recognized by the author are here adopted.

As an example let us now imagine that a certain reflector is to be employed with the object of increasing the light thrown in a downward direction by 25 per cent, the coefficient of absorption being 30 per cent.

Then by utilizing the curves deduced in the various figures we find the angles that must be enclosed within the reflector will be :—

For a	curve	of type	1a,	an	angle	between	0	degree to	73	degrees,	as derived	from Fig. 2.
,,	,,	,,	1b,	,,	,,	,,	0	,,	76	,,	,,	,, Fig. 3.
,,	,,	,,	1c,	,,	,,	,,	90	,,	127	,,	,,	,, Fig. 4.
,,	,,	,,	1d,	,,	,,	,,	90	,,	120	,,	,,	,, Fig. 5.
,,	,,	,,	1e,	,,	,,	,,	90	,,	116	,,	,,	,, Fig. 6.

Finally, a simple calculation utilizing the diagram shown in Fig. 3 may be given. Suppose that we employ a glow-lamp, having a mean spherical candle-power of 50 candles, at a distance of 1·25 metres from a round table, the surface of which it is intended to illuminate. Suppose further that the reflector is to be allowed to embrace a total angle of 110 degrees, that its coefficient of absorption is 30 per cent, and that the diameter of the table is 2 metres. The whole of the resulting increase in the downward illumination is to be expended upon the table. We can now rapidly determine the resultant flux of light by which the table will benefit.

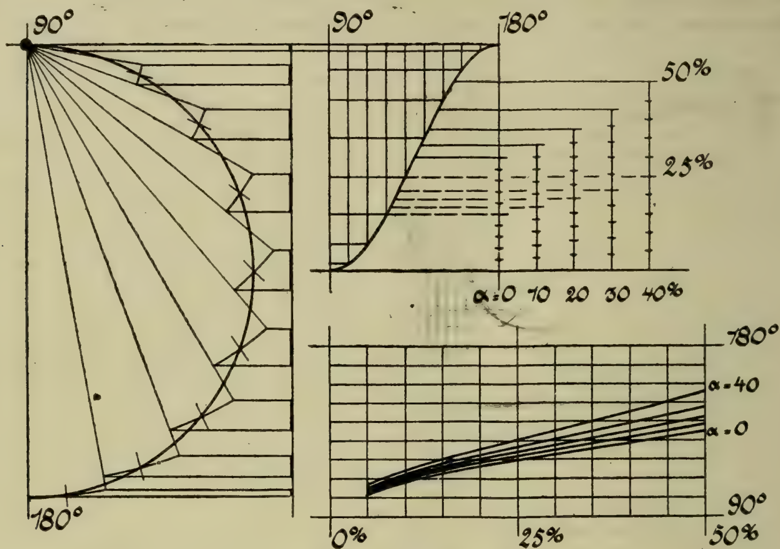

FIG. 4 (corresponding with Fig. 1c).

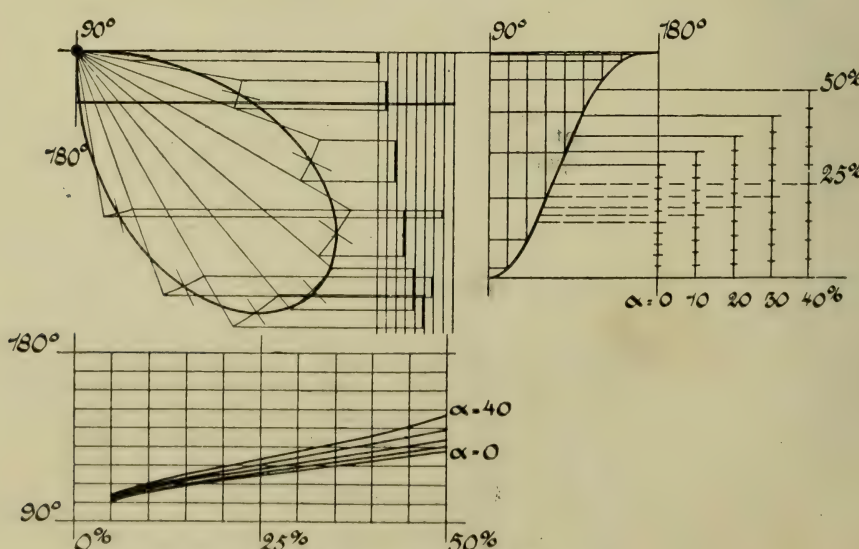

FIG. 5 (corresponding with Fig. 1d).

The tangent of the angle included by the beam of light illuminating the table on either side of the vertical, is

$$\frac{2/2}{1{\cdot}25}=0{\cdot}8,$$

and this corresponds to an angle of about 39 degrees, so that the lamp's rays will embrace an angular region extending from 180 degrees to 39 degrees to 180 degrees, *i.e.*, between 141 degrees and 180 degrees. As can readily be seen from Fig. 3, the flux of light devoted to the table from the lamp alone is only 7 per cent of the total amount of light. The reflector, however, increases the light by 50 per cent of the total flux, so that 50+7=57 per cent of the total flux of light is now available for the purpose of illuminating the table. The total flux of light striking the table is thus $0{\cdot}57\times4\pi\times50=360$ lumens. The area of the surface of the table-top is 3·14 square metres, and the amount of light available per unit area is therefore 360/3·14, *i.e.*, about 114 lux; but *without reflector*, only

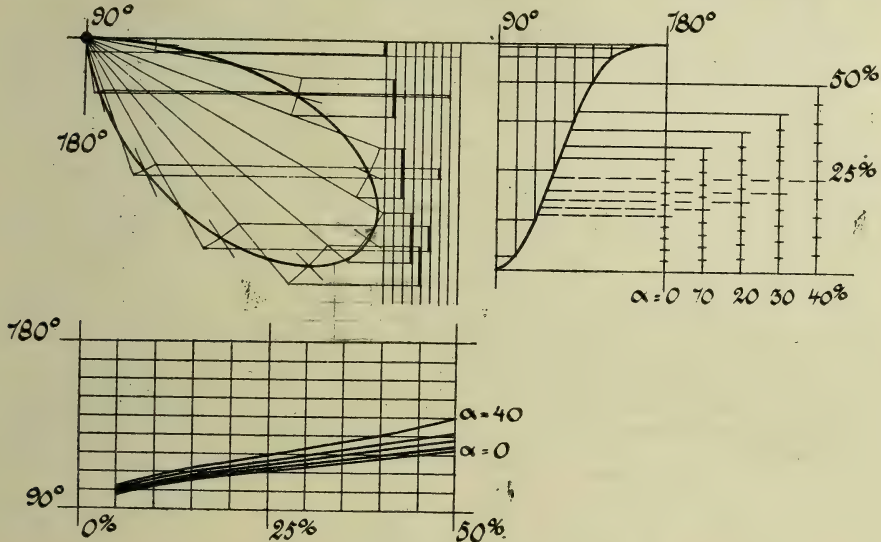

Fig. 6 (corresponding with Fig. 1e).

$$\frac{0{\cdot}07\times4\pi\times50}{3{\cdot}14}=14 \text{ lux.}$$

Many other examples of the use of these diagrams might be contrived on similar lines; the above may, however, suffice to illustrate their general applicability to practical problems.

Cantor Lectures on Illumination.

Among the events of interest to illuminating engineers during the coming month mention may be made of the series of four Cantor Lectures, dealing with the latest developments of the different illuminants, which, as announced in our issue of August, 1908, are to be delivered before the Royal Society of Arts (St. John's Street, Adelphi) by Mr. Leon Gaster, Editor of *The Illuminating Engineer*, on Feb. 15th, Feb. 22nd, March 1st, and March 8th respectively. We understand that the first lecture will deal mainly with electric lighting, the second with gas, the third with oil, petrol-air, acetylene, and other illuminants, and the fourth with several problems of illumination.

Spectacular Effect in Interior Lighting.

SOME recent numbers of our contemporary, *The Illuminating Engineer* of New York, contain some interesting particulars of the use of artificial light for spectacular effects in various New York restaurants. The production of novel displays of this kind seems to be specially characteristic of New York, and many such restaurants are regarded as show-places, and visited quite as much for what is seen as for what is eaten.

Figs. 1 and 2 show some attempts of this type in Archambault's Restaurant in the Broadway. The walls have specially illuminated decorations of the variety shown in Fig. 2, and are also ornamented with decorative artificial fruits and flowers which glisten "not from the morning dew, but because of tiny electric lights inside each bunch." This same principle is applied to the ingenious illumination by fairy Japanese lamps swaying in the breeze of an electric fan, and even beetles which, green and glowing, hang from the ceiling above.

The "Orangerie" in the Hotel Astor was one of the earliest examples of scenic decoration of this kind. Another elaborate illustration of spectacular effect is furnished by Murray's Italian Gardens, a restaurant in the very heart of the theatre district, which was originally a school-house. Here, again, there are some interesting examples of the use of light for decorative display. In Fig. 3, for instance, is to be seen a large globe of bronze and leaded green glass illuminated from within. The table-top is also of leaded glass in rich orange and red tints, lighted from below by incandescent lamps, the joints of the separate sections of the glass being concealed by trailing festoons of vines. In one of the rooms, again, the ceiling is pierced by small star-shape openings, behind which are placed electric lamps which are alternately lighted and extinguished, "giving the appearance of twinkling stars"—at the same time the effect of moving clouds is reproduced on the ceiling by the now well-known stage apparatus.

Another view of this restaurant is shown in Fig. 4. Attention may be drawn to the shaded standard lamps on each table. The general illumination in all these restaurants is said to be soft and subdued, any appearance of glare and over-brilliancy being avoided. The steps of the portico over which the water of a fountain flows, as shown in Fig. 4, are composed of stained leaded glass and illuminated from within. As a matter of fact this fountain forms only a quadrant of a circle, but being placed in the corner of a room with mirrored walls, appears complete. The use of mirrors in order to produce the impression of greater space and for the duplication of ornaments is frequently utilized in these restaurants.

Although the general illumination is low, special strong illumination is bestowed on the paintings, &c., surrounding the room. The means of lighting are carefully concealed, but it is stated that lamps of different colours are deliberately employed to enhance the colours of the painting.

The use of light for purely decorative and spectacular purposes in this way certainly offers a very interesting field for experiment. It even seems conceivable that the artist might justifiably use this method of creating pictures with good results, and with less limitation (as regards light and shade) than exists when painting on canvas. The lighting of pictures by artificial means is also a matter that deserves careful study, though how far the artist responsible for a picture could be brought to acquiesce in the accentuation of his colour effects by the use of an illuminant with some special spectrum, is another matter. It must, however, be recognized that in any case all the

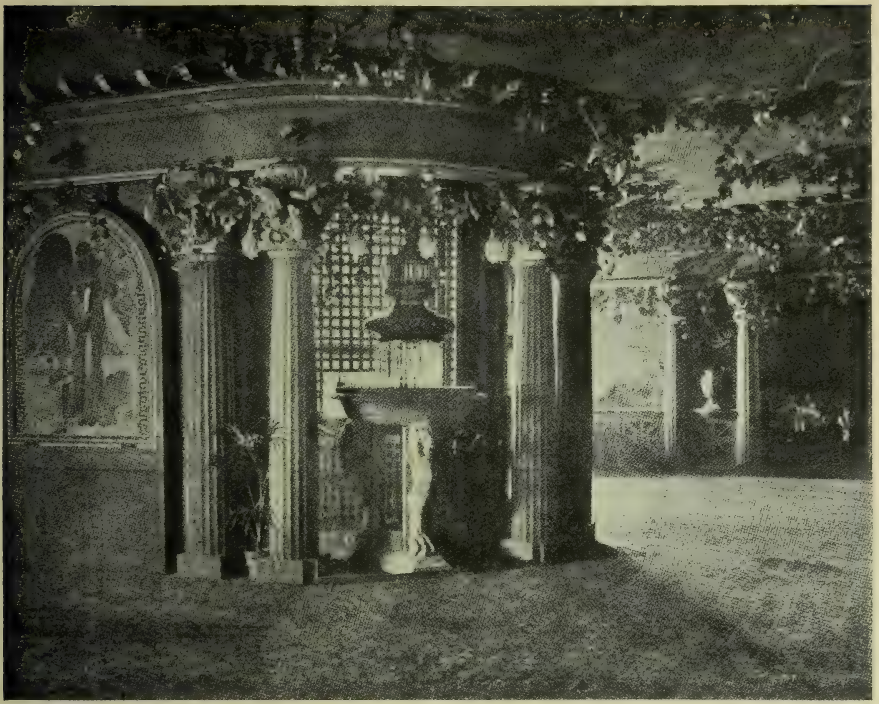

FIG. 1.—Archambault's Restaurant, Broadway, New York.

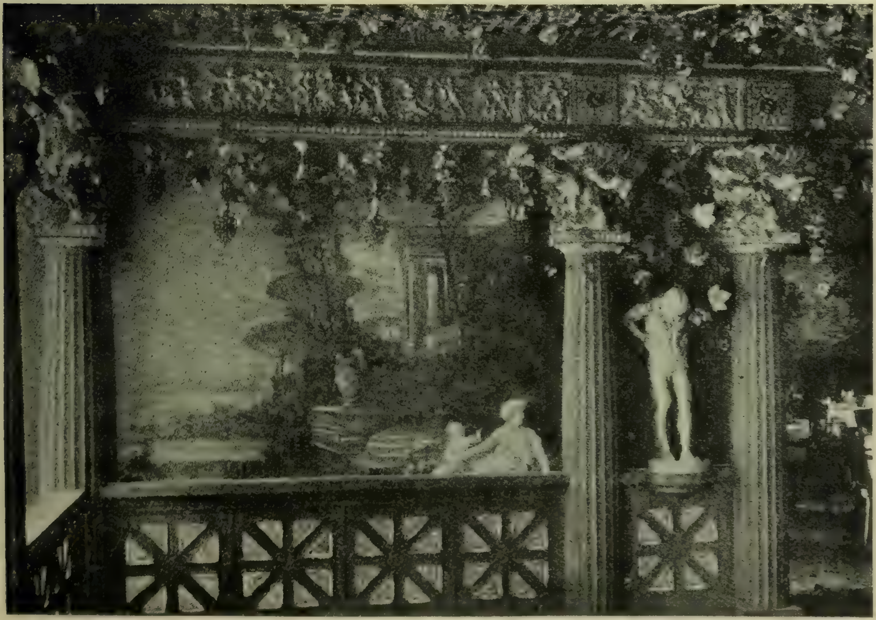

FIG. 2.—Illuminated Wall Scene, Archambault's Restaurant, New York.

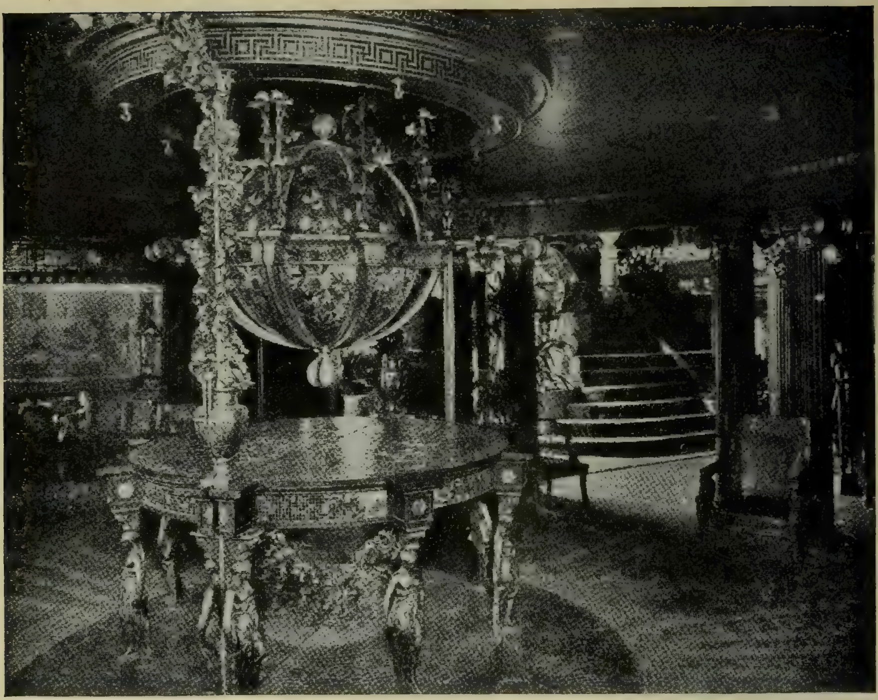

Fig. 3.—Murray's Italian Gardens Restaurant, New York.

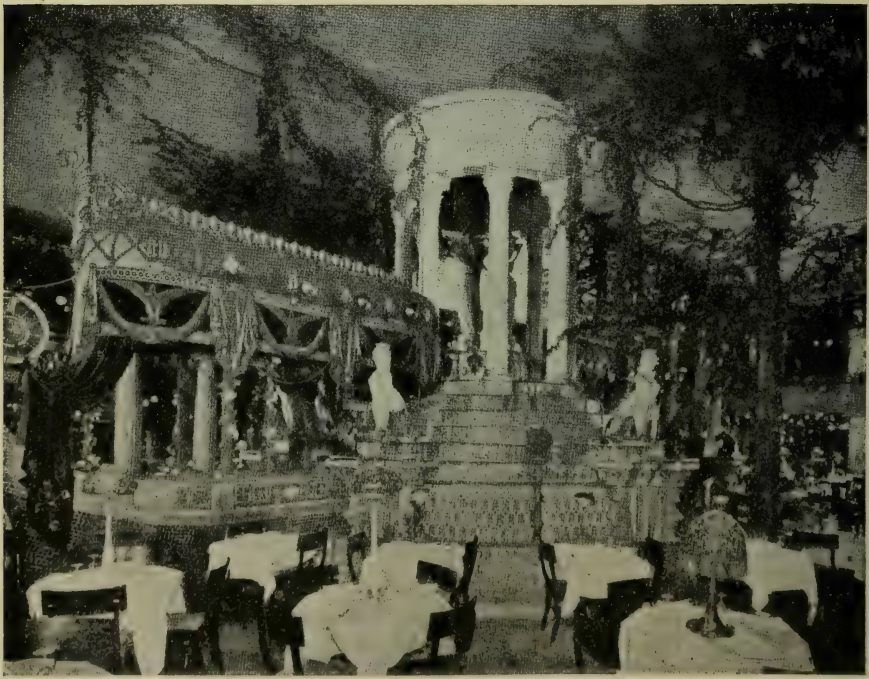

Fig. 4.—Murray's Italian Gardens, New York, Showing Illuminated Cascade.

ordinary illuminants at present available for use in this way differ considerably from daylight.

On the other hand, as regards the production of artistic effects, one can only feel that, while the use of light to this end may be a powerful weapon, it must, on this very account, be used with restraint, and might only lead to vulgarity in the hands of a designer not gifted with the requisite taste and discrimination.

Fires in Theatres and Electrical Installations.

From Our Special Correspondent in Buda-Pest.

On January 18th of this year Maeterlinck's 'Monna Vanna' was given in the National Theatre in Buda-Pest. At the conclusion of the second act the principal actors stepped in front of the curtain, which consisted of red velvet, to acknowledge the applause.

At this moment some slight draught caused the curtain to come into contact with the open flames of two torches, serving as decorations near the adjacent awning. In a moment the curtain was in flames, which spread rapidly. The iron curtain-supports dropped down, releasing the water from the large reservoir up above (which served under ordinary circumstances for the produciton of artificial rain); this flood of water overwhelmed the entire stage, thus effectually removing any danger of fire.

The audience retired quietly. Since the introduction of electric lighting, thirty years ago, for theatres, the public have gained confidence and become "disciplined to fire." When the electric light goes out people do not become frightened, as might occur in the case of gas, having learnt discretion through experience.

The decorations have naturally suffered much damage from the water. The electric installation was also not adapted to the impromptu bath, and in accordance with the recommendations of the Commission, the cable carrying the current to the banks of lights at the sides of the stage must now be changed. In fact the whole arrangements underwent disturbance that will take several days to put right.

From this accident one may draw the following conclusions: Every theatre-installation must be so arranged as to be capable of withstanding the douche of the water, following the release of the safety-reservoir; the cases carrying the lights, &c., could easily be designed to comply with this condition. All conscientious regulations for the prevention of fire rightly forbid the introduction of fuses into the actual stage-fittings.

The most dangerous locality, from the point of view of fire, is the position occupied by the light-regulating resistance, where all the wires from different points are collected together. It is desirable that in new installations some decentralization of these conductors should be introduced, which could easily be provided for by suitable switch arrangements at a distance. But in any case this locality, where most of the regulating-rheostats are situated, ought, apparently, to be protected from the flood. Of course, by so doing we also remove the protection against fire afforded by the presence of the water; for this reason the first suggestion, as regards decentralization of the conductors, &c., is very important.

Arcs, it may also be noted, cannot readily be extinguished by water, and are preferably suffocated by applying sand.

Structural Difficulties in Installation Work.

By James R. Strong.

(Paper read at the Second Annual Convention of the Illuminating Engineering Society, Oct. 5-6th, 1908; abstracted.)

The author contends that the best electrical installation, from the point of view of the first-class contractor, is that installation which requires the least amount of changing and alteration after completion.

In commercial buildings the interest on the installing cost is, of course, a factor to be considered; but this factor becomes very small in structures not strictly used for money-making purposes—as, for example, private residences.

Alterations in modern electric lighting installations utilizing some form of concealed conduit work, with iron or steel outlet boxes at the fixture locations, must to some degree cause weakness in walls, floors, or plaster; to avoid changes in such electrical installations it is necessary so to locate the outlets at the beginning of the work that all desired results may be obtained by the use of adequate lighting fixtures.

The above requirements seem very simple and easy of fulfilment, and indeed would be were all the conditions fixed; but, since every installation should be so designed as to allow a maximum amount of changes without affecting the efficiency of the results, the problem becomes more complex.

It is not sufficient to dismiss the difficulty by saying that each new tenant should do his own shifting of outlets, for this is apt to mean a deterioration of the installation as a whole. It must also be borne in mind that in many cases it is quite impracticable to shift concealed conduit outlets, and that if the outlets, as already installed, meet the demands of the prospective tenant, the space may more easily be rented to advantage. The necessary shifting, of course, can more easily be done when mouldings on the ceiling or walls are used, but this method at once cheapens the character of the work; not only are the mouldings not so safe or clean as conduit, but in moulding work it is very easy for irresponsible parties to cut in to the work and make more or less dangerous attachments.

The author suggests that, in designing the lighting for an office building, the proper methods of procedure is not the usual one of arranging the circuits in each separate office irrespective of any consideration of adjacent rooms; it is better to consider each floor as a whole.

Office buildings are generally arranged with the main or high partitions midway between windows; a certain minimum size is selected for an office space, and the larger offices are multiples of such a minimum space. If, therefore, the outlets for general illumination are placed around the ceiling a short distance inside the lines of partitions probably every possible requirement could be met by simple fixtures. This plan might involve a greater number of outlets than absolutely necessary; but the additional first cost would be more than made up in saving in the maintenance cost of the first few years. Moreover, the installation as a whole would manifestly be a better one, owing to such freedom from changes and alterations, and the offices would be more rentable.

The above general statements also apply to private residences, in which class of work there seems to be a growing tendency to limit the number and capacity of outlets to the bare requirements of a scheme of decoration and furniture layout, decided upon by the original owner, architect, or decorator with no regard to possible future developments.

Again, in a year or so the owner may wish to adopt a darker colour for his scheme of decoration with the result that there will be little or no reflection from the walls or ceiling. It then becomes necessary either to exceed the requirements of the insurance code or to do additional wiring.

But if the outlets were installed in number and capacity sufficient for the darkest probable treatment very little would be added to the first expense; and the decrease of the light to the exact amount required would then be done in the fixture and lamp.

Not only should the initial equipment be such as to cover any probable condition, but the outlets themselves should be so located that any rearrangement of furniture is easily accomplished. In a bedroom, for example, it has often been the practice to locate a ceiling outlet near the wall, or a side wall outlet near the ceiling, to provide for a dressing table fixture to light the face and hair. When subsequently the spirit of unrest takes possession of the occupant of the room and she wishes to change the position of the dressing table and the bureau, it is a difficult matter to rearrange the fixtures. If, in place of the above special dressing table fixture, four side wall outlets had been placed at the most probable locations of dressing-table and bureau, then the articles of furniture could be interchanged at will, with very slight changes in the fixtures, and perhaps no change whatever except in the glassware.

It is, of course, quite proper that the illuminating engineer should give his best skill to the design and arrangement of fixtures, glassware, and lamps at existing outlets so that the best possible results may be obtained in any installation which comes under his charge; and great credit is due to illuminating engineers for the advance made in this art during the last few years. But in any installation where the layout of the outlets is under the engineer's charge, he must bear in mind that he is dealing not only with the science of illumination, but also with the vagaries of human nature. The love of change which seems inherent in the "Genus Homo" is as much a part of the equation as is the "flux of light."

DISCUSSION.

Dr. L. Bell, the President, in opening the discussion, remarked that there was a danger that practical difficulties of the kind mentioned by Mr. Strong might be insufficiently taken into consideration by those interested in the purely engineering aspects. He himself thought that one of the greatest faults in many installations was insufficiency of outlets.

Mr. D. J. Collins blamed the owners of buildings for insisting on their own schemes as regards outlets in spite of the advice of those who knew, and then objecting to the cost.

Mr. Jones referred to the modifications in installations necessitated by the new high candle-power units. One effect of raising the standard of office illumination had been to render local desk-lighting by portable lights unnecessary. He also thought that brackets, switches, &c., ought not to be located on the inner walls of a building as they were so liable to alteration.

Mr. H. Calvert feared that putting in additional outlets to meet all possible future developments would increase the initial cost of installation unduly. He advocated the installation of receptacles in the baseboard round a room, and depending upon a general illumination rather than a local one. However, the position of doors and windows in a room usually fixed the possible positions of the different articles of furniture within reasonable limits.

Mr. Walton Forstall agreed with the last speaker as regards initial cost.

He thought the safest plan was to assume that the owner was going to use every outlet installed simultaneously, and most of the gas companies put in a pipe to meet this possibility. In the majority of cases of gas lighting, however, the consumer was satisfied with either one or two outlets in a room. In the United Gas Improvement Co.'s building in Philadelphia, however, outlets were spaced along the piping at intervals, so that if the furniture was readjusted a fixture could be moved to a more convenient outlet.

Mr. C. W. Hare contended that the important criterion with which an installation should comply was maximum efficiency; he therefore advocated the installation of as many outlets as could possibly be needed in the future, if necessary making provision for both gas and electric lighting.

Mr. J. E. Woodwell emphasized the need for careful consideration in deciding on the position of switches and the exact lights they were intended to control.

This problem in electric lighting was as important as any with which the illuminating engineer had now to deal.

Mr. F. G. McGuire remarked on the difficulty of devising a system sufficiently flexible to meet all possible needs. An ingenious way of meeting the difficulty with which he was familiar was to place round the ceiling ornamental piping or moulding, on the basis of 60 to 75 lineal feet per 660 watts anticipated. If, later on, a room so equipped were subdivided, drop lights could be obtained by tapping in on the system at any desired point.

He mentioned a case in which it was impossible to do anything above the ceilings of a building, but by utilizing the moulding system any number of local lights could be obtained.

Thus it was found feasible not only to have the desired general illumination which an illuminating engineer would provide, but also to concentrate the light for any particular purpose in a certain locality.

V. R. Lansingh mentioned a similar system, according to which channels were cut in the floor, and served to contain not merely electric light wires, but also telephone wires, &c., in addition.

Mr. J. R. Strong, in reply, said he agreed with the suggestion that fixtures should not be attached to walls in a building likely to undergo alteration; he also thought that, although multiplication of different controlling switches might be desirable in the case of residence lighting, where actual cost was not so important, it was necessary to practise economy in offices. In order to meet with possible alteration in a room, however, he advocated the distribution of a number of outlets round one in a central position. It might be true that in many cases—in a bedroom, for example—the correct position of the furniture was virtually fixed by the positions of door and window. Yet he found that people *would* rearrange it notwithstanding.

Mr. Strong agreed that mouldings were extremely convenient, but thought they were open to objection for this very reason; for any unauthorized person on the premises could tap the wires at any position with relatively little trouble, and this might easily give rise to dangerous conditions. Mouldings were unsightly, and ought only to be used in exceptional cases, when no other course was possible. Indeed they could only be justified as a last resort in cases in which the lighting had not been properly studied by the engineer and architect previous to the erection of the building.

The Kitson Empire Lighting Company: Removal of Works from Willesden to Stamford.

A staff dinner was held at the Café Monico, Piccadilly Circus, when the chair was taken by Mr. Arthur Kitson, the inventor of the system of incandescent oil lighting exploited by the above company.

The usual toasts were given and heartily responded to; special interest was expressed in the removal of the works of the company to Salford, partly to save expense, but also with the object of building up a variety of garden city, and rendering the surroundings more pleasant to the employees.

The Production and Utilization of Light.

The Laws and Measurement of Radiation.

By Dr. C. V. Drysdale.

(*Continued from p.* 21.)

The Stefan-Boltzmann Law.—The first law of radiation admitting of exact quantitative expression was enunciated by Stefan * in 1879. A study of the results of Dulong and Petit and of Tyndall led him to the conclusion that the total radiation of a body was proportional to the fourth power of its absolute temperature. Or in symbols—

$$R=\sigma T^4=\sigma(t+273)^4$$

where t is the ordinary temperature of the body on the Centigrade scale, T its absolute temperature, and σ a constant now known as the radiation constant. Boltzmann† in 1884 deduced the same law theoretically from thermodynamic principles, and showed that, contrary to the opinion of Stefan, it only applied to black bodies. The Stefan-Boltzmann law has been experimentally verified by Provostaye and Dessains, by Lummer and Pringsheim,‡ Kurlbaum,§ Féry,|| and others, over a very large range; and it is of the utmost value, as it is the only means by which a continuous scale of temperature can be obtained from low to the highest possible values. Prof. Féry has constructed a well-known optical pyrometer on this principle, which will be referred to later.

Several investigators have also attempted to determine the value of the radiation constant σ in the formula, and the following table, taken from Prof. Féry's 'Rayonnement Calorifique et Lumineux,' summarizes the results obtained:—

Observer.	Date.	Radiation Constant σ. Gramme calories per sq. cm. per sec.	Radiation Constant σ. Watts per sq. cm.
Lehnebach	1874	$1{\cdot}1\times10^{-12}$	$4{\cdot}59\times10^{-12}$
Kundt & Warburg	1875	1·01	4·21
Warburg	1875	1·10	4·59
Graetz	1880	1·08	4·50
Christiansen	1883	1·21	5·04
Kurlbaum	1898	1·28	5·32

Although the last result, that of Kurlbaum, is considerably higher than all preceding ones, it is generally accepted as the most reliable, having been obtained by means of a compensated bolometer. Confirmatory experiments, however, would seem to be desirable.

We may, therefore, write for the loss of heat by radiation from a body at an absolute temperature T in an outside temperature T_0—

$$R=1{\cdot}28\times10^{-12}(T^4-T_0^4)\text{ Calories per sq. cm. per sec.}$$

or

$$R=5{\cdot}32\times10^{-12}(T^4-T_0^4)\text{ Watts per sq. cm.}$$

As a number of sources of light, including all flames, incandescent carbon filaments, and arcs are cases of radiation from nearly black bodies, it is convenient to be able to tell at a glance the radiation from such a body at any temperature. The curves in Fig. 6 enable this to be done. One of these gives the value of R in watts per square centimeter, but as this curve rises very steeply at high temperatures, and thus makes it impossible to read off the values at low temperatures with accuracy, log R has also been plotted, which is also convenient for calculation.

As an example we may take the case of the filament of an ordinary carbon

* Sitzungsber d. K. Akad. d. Wiss Wien, lxxix., 1879.

† 'Wied Ann.,' xxii. p. 291. See Drude, 'Theory of Optics,' p. 512.

‡ 'Wied Ann.,' lxiii. p. 395, 1897.

§ 'Rayonnement Calorifique et Lumineux,' Theses, Paris.

glow-lamp, which may be considered as approximately a black. In the case of a 100 volt 16-candle-power lamp taking 64 watts, the dimensions of the filament, according to Mr. Ram, may be 7·4 in. long and 4·33 mills. in diameter, or ·1 sq. inch surface=·645 sq. centimeter. This means a radiation

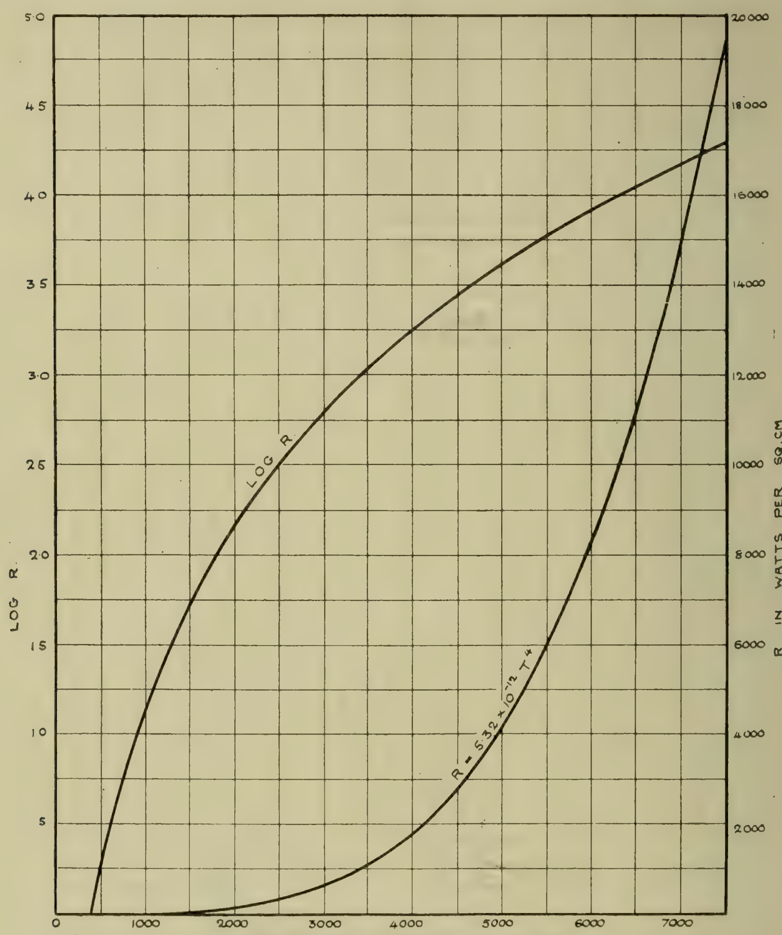

Fig. 6.

of pratically 100 watts per sq. centimeter. The log of 100 being 2, this corresponds to a temperature of 1,800 degrees Centigrade in Fig. 6, which lies between the limits of 1,300 degrees to 1,900 degrees Centigrade, given by various authorities.

It should be remarked, however, that this calculation is made on the assumption that the temperature of the enclosure is low. Prof. Féry* has, however, shown that this is not the case. The reflection of the long-waved radiation by the interior of the bulb causes its equivalent temperature to be fairly high. By an ingenious method he has found that with a filament at a temperature of 1,500 degrees Centigrade, the apparent temperature of the bulb is no less than 1,070 degrees Centigrade. The radiation from the lamp filament according to him is represented by the law $R=3\times10^{-12}\ (T^4 - T_0^4)$, when T_0 is the external air temperature.

* *Ibid.*, p. 64 *et seq.*

(*To be continued.*)

A Study on the Economical Possibilities of Lighting by Means of Carbon Filament Lamps.

BY AN ENGINEERING CORRESPONDENT.

(*Continued from Vol. II. p. 28.*)

LIFE and efficiency tests were made on a selection of 100 volt 16 candle-power lamps as follows: average watts per candle, 1·7, 2·2, 2·8, 3·25, 3·8, 4·0, 4·2, 4·5. The highest efficiency lamp obtainable was one rated at 2½ watts per candle, therefore the higher efficiency tests were carried out by over-running 8 candle-power lamps. This was done in the tests for lamps having an average efficiency of 1·7 and 2·2 watts per candle, particulars in Tables III. and IV. From Fig. 2 we find a terminal voltage of 136 is necessary to overrun a 100 volt 4 watt 8 candle-power lamp at an initial efficiency of 1·5 watts per candle.

TABLE III.

Candle-power and Life Test on three ·100 Volt 8 Candle-power Lamps run on a 135 Volt Circuit giving 35 Average Candle-power at 1·7 Watts per Candle.

Hours.	No. 1.		No. 2.		No. 3.	
	Candle Power.	Watts per Candle.	Candle Power.	Watts per Candle.	Candle Power.	Watts per Candle.
0	41·5	1·47	40	1·5	40	1·52
1	38	1·6	36	1·63	36·5	1·63
2	36	1·68	36·5	1·61	36	1·66
4	34·5	1·73	34·5	1·65	35	1·7
6	34	1.74	34	1·67	34	1·75
10	32·5	1·82	33	1·7	33·5	1·76
16	29	2·02	31	1·9	31·5	1·89
Total	245·5	12·06	245·0	11·66	246·5	11·91
Average	35	1·73	35	1·68	35·4	1·70
Useful Life	12		14		15·5	
Candle Hours	420		490		550	

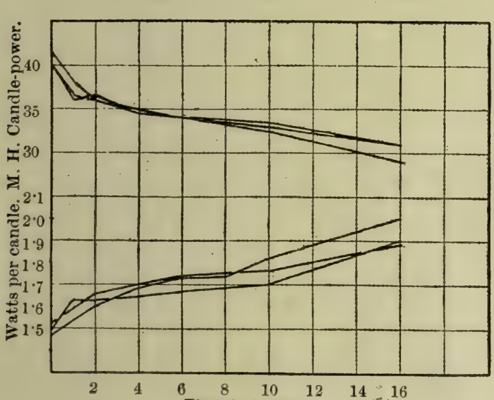

FIG. 3.—Candle-power and efficiency test of three ·100 volt lamps run at an average efficiency of 1·7 watts per candle.

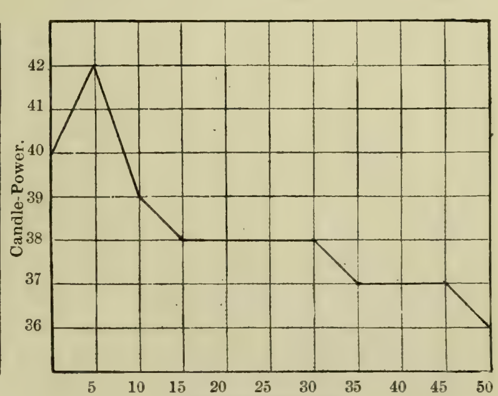

FIG. 4.—Alteration of candle-power during first 50 minutes of a ·100 volt lamp run at 1·7 average watts per candle.

In Table III. the test results are given on three 8 candle-power 100 volt lamps which were run on a 135 volt

alternating current circuit; this voltage being obtained from a tapping taken off the winding of an auto-transformer. Candle-power and efficiency tests were made every few hours till 80 per cent of the initial candle-power was reached. The test results are plotted in Fig. 3 for the three lamps, the chief point worthy of note being the rapid fall in candle-power during the earlier part

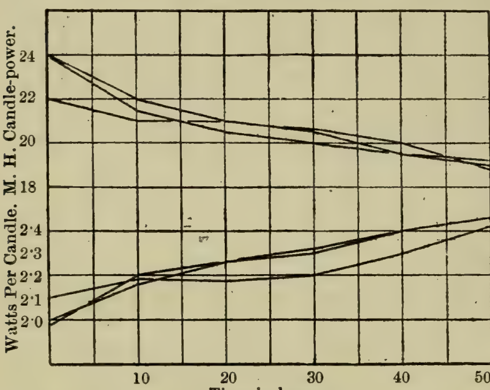

FIG. 5.—Candle-power and efficiency test, of three 100 volt lamps, run at an average efficiency of 2·25 watts per candle.

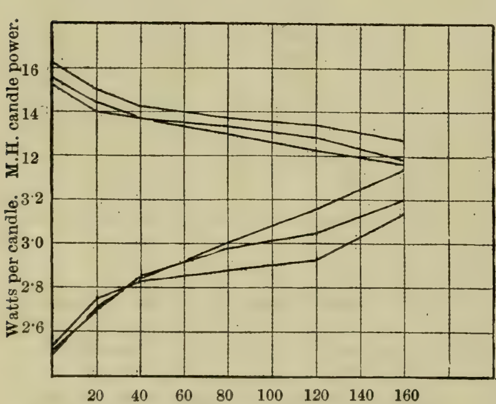

FIG. 6.—Candle power and efficiency test of three 100 volt lamps run at average efficiency of 2·8 watts per candle.

of the test. Lamp No. 2 of this series was tested for candle-power every five minutes during the first hour, the test being shown in Fig. 4.

During the first five minutes the candle-power rose to 42, suddenly falling to 39 candle-power, then falling fairly steadily during the remaining fifty minutes. Thus, at an average efficiency of 1·7 watts per candle, the useful life is of brief duration, being only 12 to 15½ hours.

In Table IV. are given particulars of a test made on three 8 candle-power 100 volt lamps burned on a 120 volt circuit, and giving about 24 candle-power each at an initial efficiency of 2·2 watts per candle. Curves are plotted from these results in Fig. 5. As in Fig. 3, the candle-power is observed to fall rapidly during the first few hours, although not to such an extent as the decrease in candle-power shown at the beginning of the test of the 1·7 watt lamps in Fig. 3. The useful life for these lamps was from 49–55 hours, at an average of 2·23 watts per candle.

In Table V. are given the test results of three 16 candle-power 100 volt lamps rated at 2½ initial watts per candle, the curves being plotted in Fig. 6. The useful life for the three lamps varied from 108–150 hours, at an average efficiency of 2·8 watts per candle. Particulars are given in Table VI. of a test on three 16 candle-power 3·0 watt lamps, and the results are plotted in Fig. 7. During the first 50 hours of burning a slight rise in candle-power was observed, being contrary to the results obtained for the lamps of higher efficiency. Although the candle-powers are less uniform than those in some of the preceding tests, yet the number of hours for useful life are in close agreement varying only from 220–240, at an average of 3·25 watts per candle.

In Table VII. the results of some miscellaneous tests on 16 candle-power lamps are shown. These lamps were originally rated from 3½ to 4 watts per candle, the complete tests are not given, as many similar tests have been published by various authorities. The average values for Tables III., IV., V., and VI. are given below:—

III.	1·7 watts	per	candle	13·8	hours.
IV.	2·23 ,,	,,	,,	51	,,
V.	2·8 ,,	,,	,,	133	,,
VI.	3·25 ,,	,,	,,	230	,,

A firm of lamp manufacturers recently published in their catalogue some figures relating to life and efficiency of glow-lamps, and these figures are given on p. 106.

TABLE IV.

Candle-power and Life Test on three ·100 Volt 8 Candle-power Lamps run on a 120 Volt Circuit giving 20 average Candle-power at 2·23 Watts per Candle.

Hours.	No. 1.		No. 2.		No. 3.	
	Candle Power.	Watts per Candle.	Candle Power.	Watts per Candle.	Candle Power.	Watts per Candle.
0	24	2·0	24	1·98	22	2·1
10	22	2·16	21·5	2·2	21	2·18
20	21	2·26	20·5	2·26	21	2·17
30	20·5	2·30	20	2·33	20·6	2·2
40	19·5	2·4	19·5	2·4	20	2·3
50	19	2·46	19·2	2·45	18·8	2·42
Total	126·0	13·58	114·7	13·62	123·4	13·37
Average	21	2·25	19·0	2·26	20·6	2·20
Useful Life	49		50		55	
Candle Hours	1030		950		1130	

TABLE V.

Candle-power and Life Test on three ·100 Volt 16 Candle-power Lamps at 2·5 Watts per candle.

Hours.	Lamp 1.		Lamp 2.		Lamp 3.	
	Candle Power.	Watts per Candle.	Candle Power.	Watts per Candle.	Candle Power.	Watts per Candle.
0	15·2	2·55	16·2	2·53	15·7	2·5
20	14·0	2·75	15·0	2·7	14.4	2·71
40	13·7	2·83	14·2	2·85	13·7	2·85
80	13·3	2·88	13·7	2·98	13·0	3·0
120	12·8	2·93	13·4	3·05	12·2	3·16
160	11·8	3·14	12·7	3·2	11·7	3·36
Total	78·8	17·08	90·0	17·30	80·7	17·58
Average	13·1	2·80	15	2·9	13·4	2·7
Useful Life	150·		140·		108	
Candle Hours	1960		2100		1460	

TABLE VI.

Candle-power and Life Test on three ·100 Volt 16 Candle-power Lamps at 3 Watts per candle.

Hours.	Lamp 1.		Lamp 2.		Lamp 3.	
	Candle Power.	Watts per Candle.	Candle Power.	Watts per Candle.	Candle Power.	Watts per Candle.
0	15·5	2 95	15·9	2·96	15·0	3·0
20	15·8	2·86	16·3	2·91	15·3	3·0
40	15·5	2·92	16·5	2·9	15·0	3 05
80	14.8	3·06	15·7	3·0	14·0	3 23
120	14	3·25	14·9	3·15	13·3	3·34
160	13·3	3 36	13·3	3·45	13·0	3·40
200	12·9	3·43	12·9	3·5	11·8	3·65
240	12·4	3·53	12·6	3·60	11·3	3·8
Total	114·2	25·36	118·1	25·47	108·7	26·47
Average	14·3	3·2	14·8	3·2	13·7	3·3
Useful Life	240		230		220	
Candle Hours	3340		3400		3000	

Initial Watts per Candle.	Total Life in hours.
2·0	150
2·5	300
3·0	600
3·5	1000
4·0	1550
4·5	2200

		100 volt.	200 volt.
(a)	$1^d - 3^d$	3·5 initial watts per candle	4·0 ,,
(b)	$3^d - 5^d$	3·0 ,, ,, ,, ,,	3·5 ,,
(c)	$5^d - 7^d$	2·5 ,, ,, ,, ,,	2·5 ,,

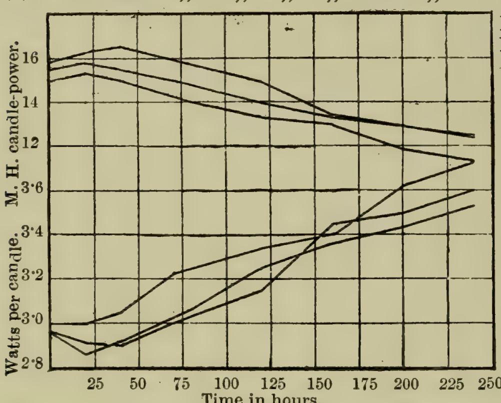

FIG. 7.—Candle-power and efficiency test on three 100 volt lamps at an average efficiency of 3·2 watts per candle.

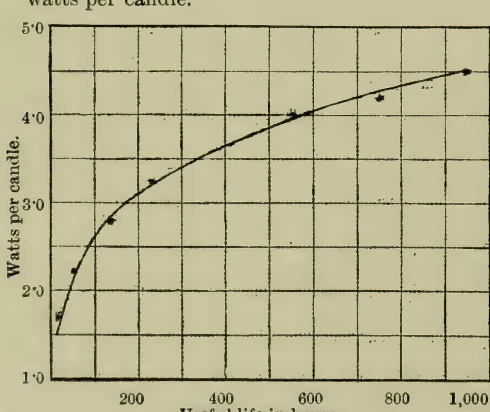

FIG. 8.—Curve showing useful life of 100 volt 16 c.p. lamps in terms of the average efficiency in watts per candle.

On examination the relation between total life and initial watts per candle was found to conform to the following formula—

$$L = W^{3\cdot35} \times K.$$

Where L=total life in hours.
,, W=initial watts per candle.
,, K=constant 15·5.

The conditions of this test are somewhat different from the tests described in this article, *i.e.*, initial watts per candle in place of "average watts per candle," and total life instead of "useful life"; therefore one would expect a considerable difference between the two investigations, although these tests help to substantiate the existence of a law connecting efficiency with life. Dealing with the investigations described in this article, the following formula was found to be in fairly close agreement with all the tests :—

TABLE VII.

Life and efficiency of 100 volt 16 candle power lamps ranging from 3·8 to 4·5 watts per candle.

Average Watt per Candle, during Life.	Useful Life
3·8	450
4·0	550
4·2	750
4·5	950

$$L = W^4 \times K.$$

Where L=useful life in hours.
Where W=average efficiency in watts per candle
and K=2·25, the constant for 100 volt 16 candle-power lamps.

In Fig. 8 a curve has been plotted from the values given by this formula at different values of watts per candle, the actual values obtained by test being indicated by a cross. The curve is seen to be a fair average of these points, and is, therefore, fairly accurate for purposes of predetermining the useful life from the efficiency. In instances where it is only convenient to estimate from the initial efficiency, some 10 per cent should be added to this value in order to approximate its average efficiency before proceeding with the calculation of the useful life. Before continuing further with the comparison of 100 volt lamps, the tests carried out on 200 volt lamps will be described.

In Table VIII. candle-power and life tests are given for three 8 candle-power 200 volt lamps burning on a 240 volt circuit, and giving an average of 21 candle-power, the results being plotted in Fig. 9. The same rapid drop in candle-power at the commence-

TABLE VIII.

Candle-power and Life Test on three 8 Candle-power 200 Volt Lamps, run on a 240 Volt Circuit, giving an Average of 21 Candle-power at 2·25 Watts per Candle.

Hours.	No. 1.		No. 2.		No. 3.	
	Candle Power.	Watts per Candle.	Candle Power.	Watts per Candle.	Candle Power.	Watts per Candle.
0	25	2·0	24	2·04	24·5	1·98
5	22	2·13	20·5	2·29	23·0	2·08
10	21·5	2·16	20·0	2·35	21·0	2·26
15	21·0	2·24	19·5	2·38	20·0	2·35
20	21·0	2·24	19·3	2·40	19·6	2·39
30	19·0	2·45	19·0	2·42	—	—
Total	129·5	13·22	120·0	13·88	108·1	11·06
Average	21·6	2·2	20·0	2·32	21·6	2·22
Useful Life	25		29		20	
Candle Hours	650		580		430	

TABLE IX.

Candle-power, and Life Test, on three 8 Candle-power 200 Volt Lamps, run on a 230 Volt Circuit, giving an Average of 15·3 Candle-power at 2·8 Watts per Candle.

Hours.	No. 1.		No. 2.		No. 3.	
	Candle Power.	Watts per Candle.	Candle Power.	Watts per Candle.	Candle Power.	Watts per Candle.
0	20	2·4	19	2·5	19·0	2·45
5	18·8	2·52	17·2	2·7	18·0	2·58
10	17·9	2·63	16·1	2·9	16·9	2·71
20	17·3	2·71	15·9	2·93	16·1	2·86
30	16·6	2·8	15·4	3·0	15·5	2·96
40	16·2	2·86	15·3	3·01	15·3	3·04
50	15·5	3·0	15·0	3·08	15·2	3·06
Total	122·3	18·92	113·9	20·12	116·0	19·66
Average	17·5	2·7	16·3	2·88	16·6	2·82
Useful Life	44		42		50	
Candle Hours	770		685		830	

TABLE X.

Candle and Life Test on two 8 Candle-power 200 Volt Lamps, run on a 220 Volt Circuit, giving an Average of 13·7 Candle-power at 3·15 Watts per Candle.

Hours.	No. 1.		No. 2.	
	Candle-power.	Watts per Candle.	Candle-power.	Watts per Candle.
0	15·2	2·86	15·8	2·75
20	14·0	3·08	15·7	2·80
40	13·5	3·18	14·7	2·92
60	13·1	3·25	14·0	3·03
90	12·7	3·36	13·3	3·26
120	12·3	3·44	12·9	3·32
150	11·9	3·56	12·3	3·46
Total	92·7	22·73	98·7	21·54
Average	13·3	3·24	14·1	3·08
Useful Life	135		140	
Candle Hours	1800		1970	

ment of the test took place as was formerly observed for the high efficiency 100 volt lamps, although the results are less uniform, the useful life varying from 20–29 hours, at an average efficiency of 2·25 watts per candle. Three 200 volt lamps were tested on a 230 volt circuit, giving remarkably uniform results for life and efficiency, the particulars of test being contained in Table IX. and Fig. 10. The useful life varied from 42–50 hours, at an average efficiency of 2·8 watts per candle for the three lamps.

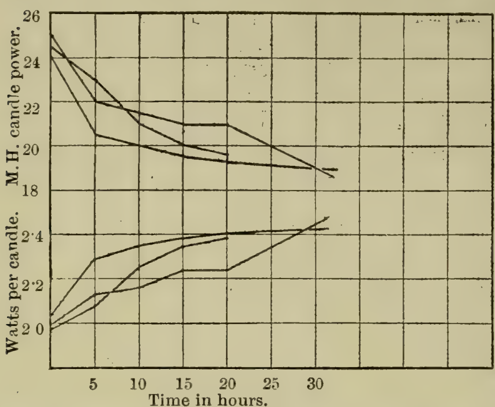

Fig. 9.—Candle-power and efficiency test of three 200 volt lamps run at an average efficiency of 2·25 watts per candle.

In Table X. the figures are given for a test of two 200 volt 8 candle-power lamps burned on a 220 volt circuit. From the curves in Fig. 11 it is seen that somewhat different results were obtained with the two lamps. The candle-power of lamp No. 1 fell rapidly at the beginning of test, while lamp No. 2 remained fairly constant in candle-power during a similar period.

Practically the same useful life was given by both lamps, being from 135–140 hours at 3·24 to 3·18 watts per candle.

Table XI. includes some figures for useful life, obtained from 200 volt 16 candle-power lamps for varying efficiencies.

The mean values for Tables VIII., IX., and X. are given below :—

VIII. 3 lamps, 2·25 watts per candle, 24·5 hours.

IX. 3 lamps, 2·8 watts per candle, 45 hours.

X. 2 lamps, 3·16 watts per candle 137.5 hours.

E. G. K.

(*To be continued.*)

Electric Head-Lamps for Chicago Street Scrapers.

The increased spread of modern traffic and the requirements of these changed conditions seem to have given rise to an interesting new development in the streets of Chicago.

In order to protect the night-workers engaged in sweeping the roadways from being run over by the many noiseless and rapidly approaching motor-cars, the South Park Commission have equipped them with small metallic filament head-lamps, which are worn upon the cap, the current being supplied by a small pocket storage cell, containing special "jellyfied" sulphuric acid. The cell weighs 1½ pounds, and its charging rate is ½ ampere. The weird appearance of these small and bright lights bobbing about in the traffic by night is a novel feature in the streets of this city.

Annual Meeting of the Illuminating Engineering Society.

The Annual Meeting and election of officers of the Illuminating Engineering Society was held on Friday, Jan. 8, at 8 p.m., at the Machinery Club, New York City, preceded by a dinner at 6 p.m.

Better Light and Air for Miners

By A. Cressy Morrison.

For several years acetylene has been used in miners' lamps in France, Germany, and Belgium to a large and steadily increasing extent, until at present it is used almost exclusively in over two hundred mines, and by approximately fifty thousand men. The light is satisfactory, saves nearly 50 per cent of the cost, at the same time giving better illumination. Mining engineers have been more or less familiar with this fact, but the introduction of acetylene into mines, up to the last two years, has been very slow in the United States. Its use is now, however, coming to be recognized as an important advance, and it promises shortly to replace all other means of illumination, except in special cases.

It is seldom that an improvement in quality or advantage is accompanied by reduction in cost, but the paradox is a reality in the case of acetylene.

Candles, which are largely used throughout our Western mines, remove seven times, and kerosene five times as much oxygen as acetylene. The products of combustion given off by candles are ten times and from kerosene nine times as much as that given off by acetylene. While acetylene in a mine gives off no smoke whatever, every miner is familiar with the difficulty from the products of combustion given off by other illuminants. Acetylene, therefore, makes for the life and comfort of the miners, protects them from the degenerating effects of insufficient oxygen, and removes the one important cause of lung and throat troubles. The actual amount of illumination given by candles and kerosene is lessened by a very large percentage by the smoke and mist which so rapidly accumulate, whereas all the light given by acetylene reaches the point to be illuminated without any interference whatever.

It has been found, in actual experience, that in entries which are sixty to seventy feet ahead of the air, there is not the slightest particle of smoke from an acetylene lamp, and the entry is just as clear at the end of a shift as it is at the beginning.

An interesting thing about acetylene is the tenacity of the flame. It is not easily blown out, the rapid motion of the miner will not cause it to flicker badly, and it burns brilliantly in an atmosphere so foul that candles fade and go out. In fact, acetylene will not deprive the miner of light until the atmosphere is so bad it will not support life.

For underground surveying and mine-inspection the use of acetylene is of great importance. Maps and records escape the usual accompaniment of grease and smudge. The acetylene flame is so small and clear that it affords an accurate point on which to sight instruments.

Another use for acetylene in somewhat larger units is found where the rays are concentrated by a reflector, in which case a brilliant illumination can be thrown into inaccessible places where distant bays, high hacks, caved places and other difficult and otherwise hidden parts of the mine can be explored with convenience, and, in case of emergency, without danger.

Acetylene is especially advantageous as a cap lamp for drivers, and it has been found, where mules are used, that they can see much better and are not nearly so liable to stumble.

The very bad quality of oil for miners' use, which has in some States called for laws establishing a standard quality—laws, by the way, which are frequently violated by a species of adulteration which almost defies detection—is becoming another powerful argument in favour of the substitution

of some illuminant which cannot be adulterated.

In this connexion, it is interesting to realize that acetylene is made in the miner's lamp as used, the principle being the bringing of water into contact with the carbide as the gas is burned, and in just sufficient quantity. The difficulties of this problem have been effectively overcome. As soon as the pressure of gas reaches the proper point for burning, it holds the water in check until the consumption at the burner has so reduced the pressure that the water comes in contact with the carbide again.

In actual practice, it has been found that four ounces of calcium carbide at four cents per pound will give nearly ten candle power clear illumination without smoke for five hours. One-half pound, or two cents' worth, will give the same illumination for ten hours. Candles in many parts of the country, counting four candles to the ten-hour day, would cost five cents per day. There seems, therefore, to be no reason why acetylene should not be introduced provided a proper lamp at an economical price can be devised. As a matter of fact, practical experience has demonstrated that some of the miners' lamps now upon the market meet all the necessary requirements as regards economy, lasting quality, and practicability in use.

Acetylene miners' lamps are now frequently found in mines in the United States — Pennsylvania, New Jersey, and Illinois leading, though many other States are using the new light. The greatest number used by any one concern in its mines is probably by the New Jersey Zinc Co. of New York, which has adopted acetylene illumination for all its mines. The number of miners' lamps in use in the mines of this company is about 3,000, and it has been found, in practical use, that the saving is at least two cents per day for every miner.

The whole method of using acetylene is so simple, and the lamps now in practical use are so satisfactory, that the subject of better illumination in mines is worthy of the attention of every mine owner and engineer. It is equally worthy of the attention of every mining organization, as well as every individual miner, because a change to better illumination at half the cost, with greater output, safety, comfort, and, above all, good health, are matters of such vital importance that no careful manager will fail to investigate the subject.

Street Lighting Contracts and the Tungsten Lamp.

In the United States the application of tungsten lamps to street lighting has been exciting a considerable amount of attention, and a recent number of *The Electrical Review* of New York takes the opportunity to urge the advisability of perfect frankness on the part of central stations in dealing with municipal and other authorities when drawing up contracts for street lighting. The relative merits of the carbon, graphitized carbon, and metallic filament lamps ought to be clearly set before the authorities, and the attempt to conceal the low-power consumption of high candle-power tungsten lamps, based on a fear that it may induce municipal bodies and others to lower the annual rate per lamp, is a short-sighted policy.

It is much wiser, it is urged, to impress upon authorities the benefits that are to be gained by the use of the newer illuminants. It is more than likely that they will desire to secure a higher standard of illumination, and many cases have occurred in which even a higher annual rate per lamp has been conceded in acknowledgement of the improved conditions.

In reality the central station and the authorities should both benefit by the introduction of the new lamps, if only a frank and wide standpoint is taken.

Some Practical Points in the Design of Fixtures.

By an Engineering Correspondent.

The subject of fixture-design offers a wide field for study at the present moment, when so many different illuminants are available, and the importance of satisfying æsthetic and other requirements is becoming increasingly realized. With the many wide and interesting questions connected with these aspects of artistic design, and the reconciliation of decorative effects with good results from the standpoint of practical illuminating efficiency, the writer does not propose to deal on this occasion. It is only his wish to draw attention to a few practical points, which, perhaps, are in danger of not being sufficiently generally recognized.

A very usual method of attaching a glass shade to the holder of an electric lamp is shown in Figs. 1 and 2.

The gallery carrying the shade is merely gripped between the two rings on the lamp holder ; in some cases no gallery is required, the shade itself having a suitable aperture by means of which it is threaded on between the rings in the usual way.

This method is often regarded as satisfactory for shades of a light character, but it is open to several objections from the standpoint of practical design, especially when the fixture is liable to adjustment in careless hands. For it will be seen that the support of the shade is entirely dependent on the slight security of the perfection of grip of *both* the rings on the holder. If the thread is worn, or the ring is not properly screwed up initially in either case, it may easily gradually work loose, when the glass is released at once and falls to the ground.

An accident of this nature is especially liable to happen when the fixtures are habitually dusted or twisted about by careless hands. Most people have occasionally found some difficulty in getting the ring properly on to the thread, and an impatient worker might easily leave the ring in a "jammed" condition, and not properly screwed on at all. Apart from this one occasionally finds cases on which the threads cut on the ring and holder are not quite

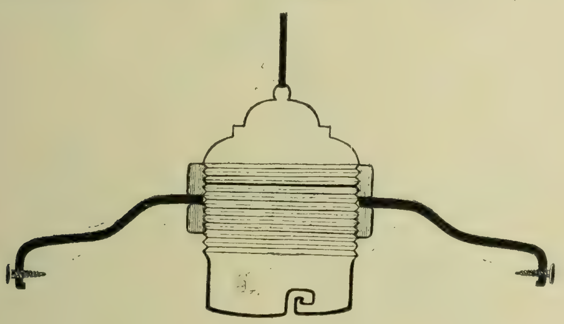

Fig. 1.

Fig. 2.

identical, and the German Institution of Electrical Engineers have recently devoted special efforts towards securing uniformity in this respect.

In Fig. 2 the defect of the hanging cord is avoided, but it will be seen that the weight of the shade still rests upon the rings of the holder. It may also be pointed out that the absence of any gallery is an objection, in that it makes it inconvenient, in the case of many shadows of narrow dimensions,

Fig. 3.

to insert the hand and screw up the lower ring. This, again, is liable to result in the ring being imperfectly screwed home. But when an open gallery, such as that shown in Fig. 1 diagrammatically, is used, the shade can be first detached, and there is then no obstacle to interfere with the free play of the fingers.

Another recognized source of objection lies in suspending even comparatively light fixtures from the flex carrying the current. Any imperfection in the cord-grip, &c., coupled with habitual twisting by those dusting the shade, may eventually wear through the insulation and cause a short-circuit between the two wires, once more enabling the whole fixture to fall to the ground.

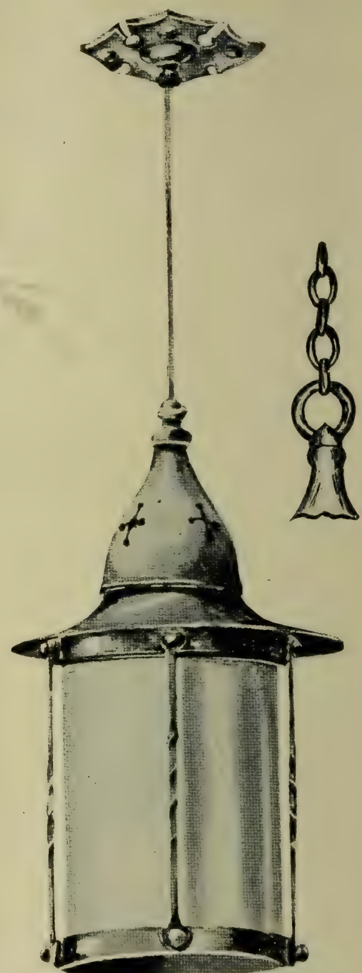

Fig. 4.

Even such comparatively light fixtures as those shown in Fig. 3 are open to this objection; but when it is desired to use the heavier types of diffusing globes the point is worthy of more serious attention.

As a matter of fact one not infrequently meets extremely heavy fix-

tures depending entirely on the cord. Sometimes, even when chains of a substantial character are provided for the individual pendants in a cluster, the fixture as a whole is supported in this way.

There may, no doubt, be occasions on which it is legitimate or even almost inevitable to rely upon the cord for some support, but one would recommend that strong chains carry the weight of all but the lightest fixtures, and especially those that are erected in positions in which their fall might have dangerous consequences.

Another point that might justifiably be urged against the use of slender flex to carry fixtures is that æsthetic and psychological considerations alone would often seem to demand something more substantial. A long line of flex terminating in a more or less massive globe, &c., is apt to arouse an uneasy impression of insecurity, and such a feeling, even if only sub-conscious, may be influential in determining a customer to reject a given type of fixture.

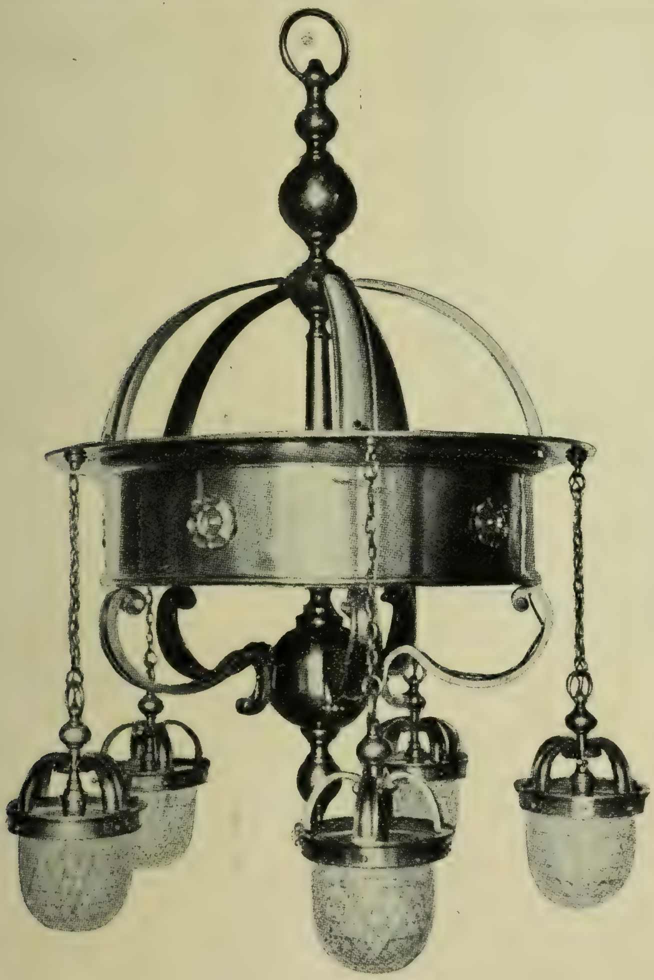

Fig. 5.

Moreover, on æsthetic grounds, a means of support that is too slender *in appearance*, even if though strong enough in reality, would be condemned. Yet one occasionally meets fixtures where the effect of an antique form of metalwork, often really heavy and massive,

but also yet more frequently deliberately made to appear so only, is neutralized by the use of the slender supporting cord.

The artistic defect in such instances arises through the creation of two

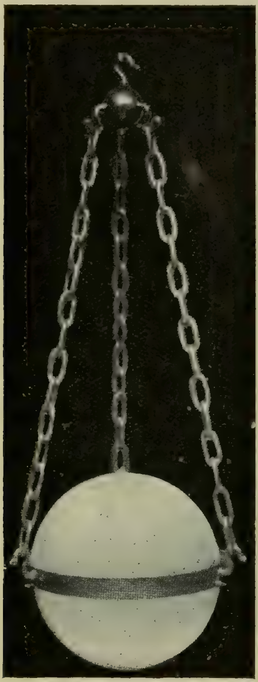

FIG. 6.

contrary impressions; the lamp itself gives the idea of massiveness and solidity, but the slender cord by which it is supported counteracts this suggestion.

To the writer, for instance, the arrangement shown in Fig. 4 seems open to this objection, for the general feeling of the design of the lamp is that it is distinctly massive, bringing to mind associations connected with old and heavy watchman's lantern. Therefore it would seem preferable, if on this account alone, to utilize a more or less massive chain of the type shown adjacent to the fixture. One could, however, call to mind instances in which fixtures having still a more heavy and substantial appearance—even accentuated by beaten or hollow metal-work, much lighter than it actually seems to be to the eye—in which the effect so produced is nullified by the use of a slender cord for support.

The fixtures shown in Figs. 5 and 6 seem to embody the general methods of support, advocated in this article.

The general suggestion of the fixture shown in Fig. 5 is distinctly substantial, but this impression is enforced and not contradicted by the supporting ring at the top and the chains for the individual lights. It will also be seen that the carriers holding the small glass shades seem to be adequately supported, and are not merely dependent on the grip of the rings on the lamp-holder. Also it will be noted that the globes themselves can be detached from the carrier, thus enabling the fingers to find room to take out a lamp, remove the rings on the holder, &c., in comfort.

Similarly the chains supporting the massive Holophane globe are such as the requirements demand.

Revolving Illuminated Signs.

A RECENT letter in *The Electrical World* of New York describes some arrangements for mechanically rotating illuminated street signs, and thus securing the intermittent light effect that is so powerful as a means of attracting attention, without the necessity for expensive electrical methods of control.

A simple example of such a device is afforded by an adaptation of the well-known vertical wind-driven strip-signs that are to be seen revolving in many of the streets of London. Such signs can be electrically illuminated if a contact-ring and brushes be provided to take the current to the lamps, and its simplicity and inexpensive nature is a great recommendation.

Selling Gas During the Depression.

By F. A. Willard.

(Abstract of Paper read at the Annual Convention of the Commercial Gas Association in Chicago, U.S.A.)

In the paper Mr. F. A. Willard has sent us, the author describes some of the methods followed by the Rochester Gas Co., N.Y., during the financial depression in the United States. The paper will be mainly of interest to our readers on account of the broad aspect again taken from the consumer's standpoint.

Briefly stated this policy seems to have been early determined upon—to continue activity during the impending financial panic, and to endeavour not only to promote a friendly feeling towards the company, but also to stimulate confidence.

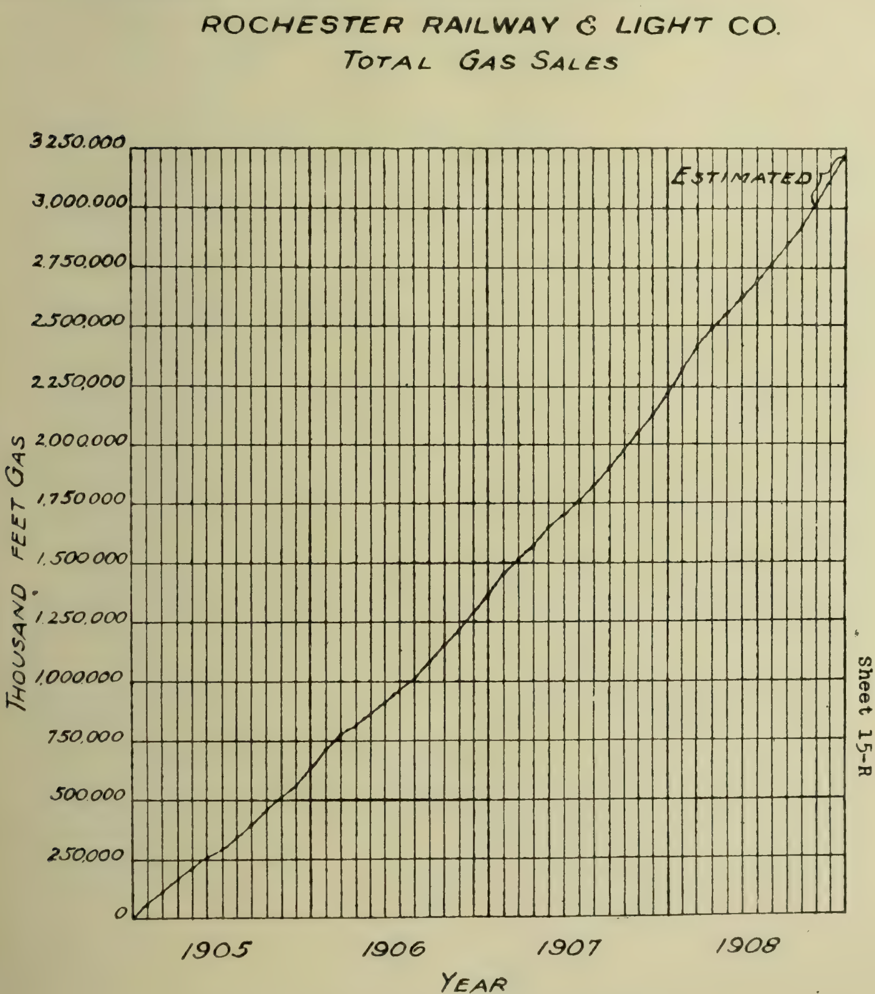

Fig. 1.—Total Sales of Gas during years 1905-1908.

As a means of achieving these ends special prominence was given to the publicity campaign among consumers; during the depression the regular canvassing staff was kept at its normal strength, and special demonstrations

of gas-lighting, &c., were given. In so deciding the company were largely influenced by the evident disadvantage of rendering the present organization imperfect, and thus losing ground through being eventually unable to take full advantage of the returning prosperity.

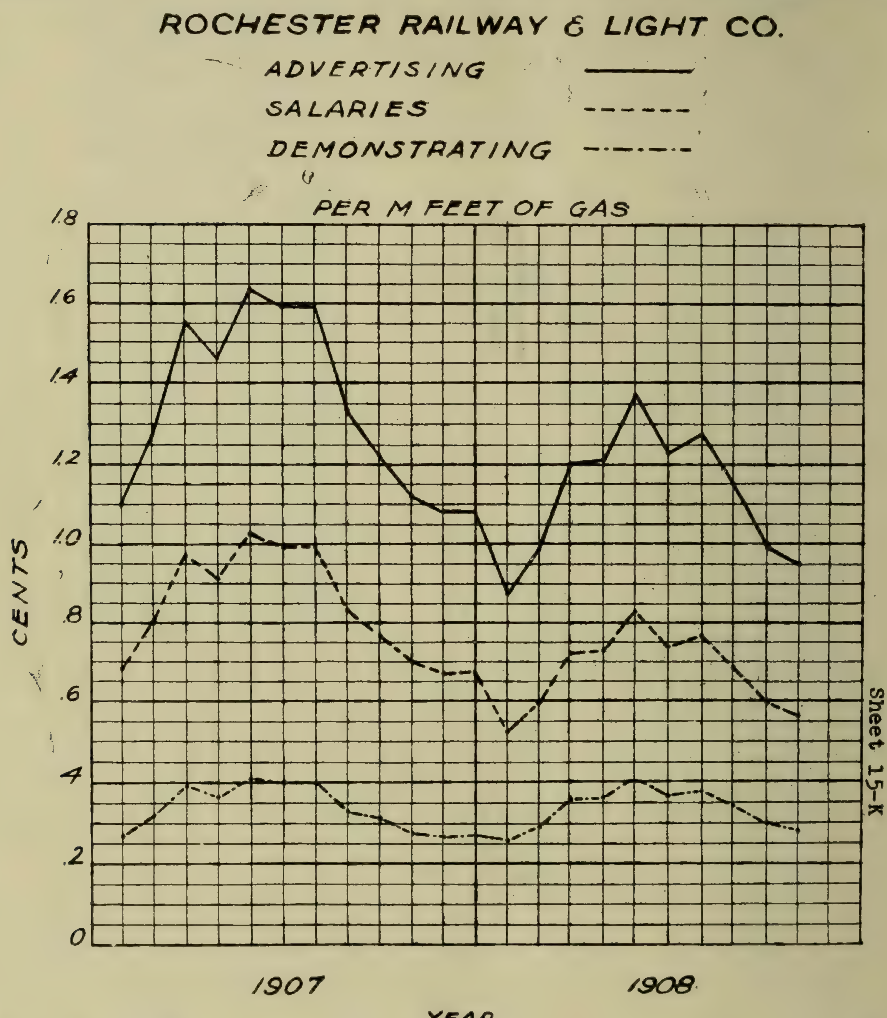

FIG. 2.—Relative Expenditure in Advertising, Salaries, and Demonstrations in years 1907-1908.

As an illustration of the efforts of the company and their results, attention may be drawn to the charts shown in Figs. 1, 2, and 3.

The first step in the publication campaign was the reorganization of the "Complaint Department." In Fig. 4 will be noticed, hanging in a conspicuous place over the counter a sign bearing the word "Information." This word has replaced the word "Complaints."

Up to the time of the reorganization of the department, it was customary to take each individual complaint as it came up, look up the details in connexion therewith, and dispose of the matter on the spot. This system has several bad features. It was necessary in many cases to obtain information from the ledger clerks, or by telephone from the various departments. This involved time, and while the information was being obtained, the customer

had to stand awaiting the result, being surrounded by a crowd of people whose troubles, seeming and real, were magnified in proportion to the length of the delay. This condition also prompted a mutual exchange of sympathy and condolence that resulted in making it difficult to reason with them. It was, therefore, decided to place this department under the supervision of the Commercial Department, with one man directly in charge.

To prevent congestion at the Information Desk, record sheets are now prepared, and each clerk given a separate sheet. In the case of a party looking for information that cannot be given directly, the name and address are taken, together with a statement of the nature of information required. The customer is now courteously told that the matter will have attention, and that he will be notified as soon as it is taken care of; and at the earliest opportunity the clerk makes out necessary orders, covering each specific case. These record sheets are prepared in duplicate, dated, signed by clerk, and at the end of each day are turned in to the man in charge of the counter, duplicates being kept by the clerk, who is held responsible for each of the entries on his sheet. The clerk must follow these up to see that each case has received proper attention, and when completed order returns from the shop, or elsewhere, it goes to the man in charge of the department, who checks them up with the daily sheets, any unchecked names indicating that

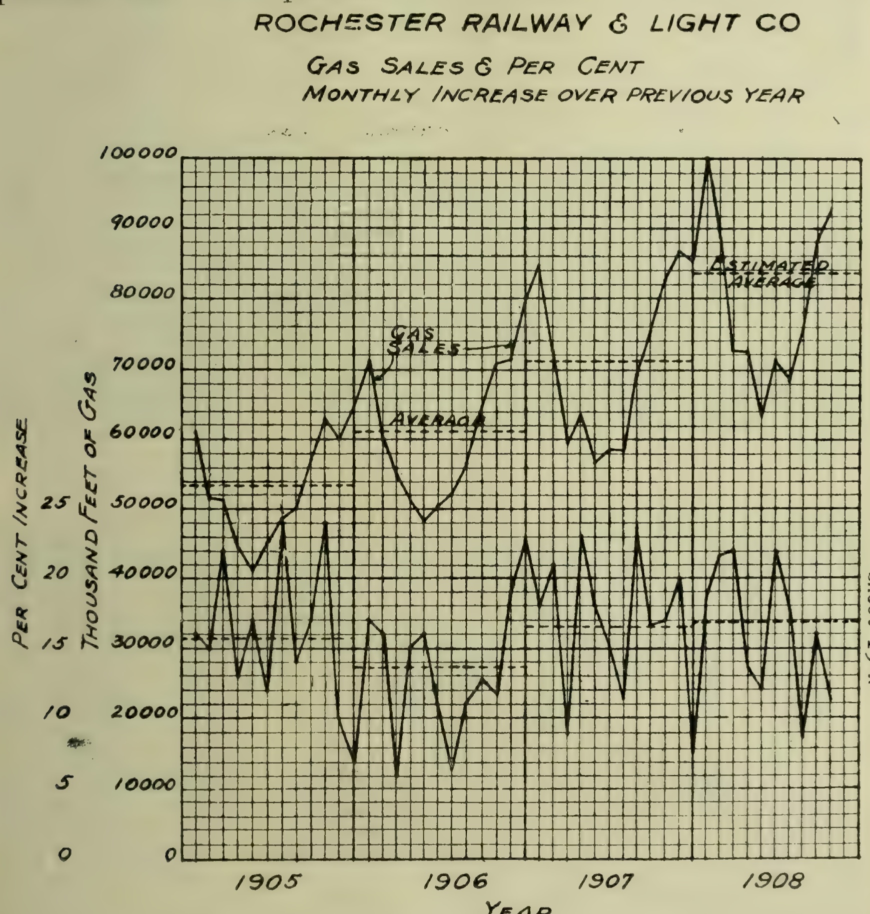

FIG. 3.—Percentage Increased Sales of Gas, 1905-1908.

FIG. 4, showing position of Bureau of Information.

FIG. 5.—Model Room lighted by Gas.

the matter has not been disposed of.

When completed orders reach the man in charge of the Information Desk, the number of the form letter required is noted thereon, and letter written. These letters are sent out without a return postal card or postage, and replies there received to approximately 60 per cent.

The use of these form letters in this department presents additional evidence of personal attention on the part of the company to the consumer, that otherwise might, in many cases, be lacking.

A special department was also created to deal with the urgent cases, which are bound to occasionally occur, when a consumer is told that some improvement will be made, but the matter is overlooked, with the result that he is correspondingly annoyed.

Close and special attention in such instances, besides its general beneficial effect, not infrequently leads to sale of new apparatus. In addition canvassers are being constantly dispatched on "missionary work," teaching the consumer how to read his own meter, how to make the most economical use of his installation, &c., and any adjustments that can be made without expense to the consumer are promptly carried out.

Attention was also bestowed upon the treatment of customers, who, having failed to pay their bills, are no longer on the consumers' list. This problem was met by installing a special prepayment meter, so adjusted that a predetermined portion of each quarter-dollar insertion is applied to the unpaid account. Experience showed that it was comparatively easy to "sign up" a delinquent on the basis of a 55 cent payment due on past accounts for each 1,000 cubic feet of gas consumed. Within a few months 500 of these meters were installed.

During the year the costs of advertising, so far from being decreased, were added to by 10 per cent, special efforts being concentrated on demonstrations of office lighting, model kitchens, special classes of living rooms, &c. Two effective demonstrations of this kind are shown in Figs. 5 and 6.

Fig. 6.—Spectacular Advertisement and Premises for demonstration of Gas for Heating, &c.

The Progress of the Gas Industry.

(Address by Mr. A. Cressy Morrison before the Illuminating Engineering Society, Chicago, Dec. 10, 1908. Slightly abbreviated).

GENTLEMEN and Fellow Members of the Illuminating Engineering Society: I deeply appreciate the fact that I am a member of the Illuminating Engineering Society, and it is not only as a member that I desire to speak to you to-night, but also as a representative of a great industry.

The National Commercial Gas Association, in extending to you an invitation to hold a meeting of your Society in this building, is joined by the American Gas Institute. Both these great organizations desire that the Illuminating Engineering Society shall, as their guests, see for themselves the progress of the gas industry, as expressed by the Gas Appliance Exposition, which now fills the Armory with light and attractiveness. On behalf of the gas industry and these Associations, I acknowledge with appreciation the thanks which you have extended, but let me say that the invitation was so cordial that we all feel the greatest gratification in your presence, and the opportunity which has thus come to us to show our deep appreciation of the unique position which the illuminating engineer holds to-day in relation to the whole subject of the manufacture and distribution of light.

The Illuminating Engineering Society has been persistent in its invitation for the gas fraternity to join with it in its broad desire to promote the use of more and better illumination, and I feel that the industry which I represent is now in full sympathy, and accord with your organization, and will give it, in full measure, its support.

It has been said that your organization has proved more attractive to those who have given greater attention to electrical illumination. I think perhaps that the young men who are devoting themselves to electricity were a little quicker to understand the possibilities and benefits to be derived from more light than our industry has been, but I feel that a thorough awakening has taken place, and that the gas man will see more clearly because of the Illuminating Engineering Society, and in turn, I believe, that the exposition of gas progress which you are to see to-night will arouse in the minds of those who have confined themselves closely to the electric field, feelings of surprise and pleasure that their brother in the gas field has not been without inventive genius, but on the contrary that the development has been wonderful.

What is the field of the illuminating engineer? Is it not the control and direction of the octave of vibrations in the all pervading ether without regard to the source from which they emanate? The illuminating engineer should give us better windows that the glorious sun and the diffused light of day may enter; and when "old Sol" has turned the corner of the earth, the illuminating engineer should light up the darkness with these same rays which have been stored as energy, whether it be from the candle flame or the flame of the open burner, whether it be from the delicate mesh of the incandescent mantle or the glow of the carbon filament, whether it be from the vapour tube or the sizzling crater of the electric arc. It is the greatest purpose of the illuminating engineer to see that the best possible light for the object in view is used, that it is properly directed, and not wasted, and to give the human eye as near an approach to the light of day as inventive genius can devise. Yours is a great profession, gentlemen, and yet you are at the beginnings of your progress. Think what the illuminating engineer, aided by the student of physics, of chemistry and mechanics, has accomplished in the last generation! Why, it is only 25 years from the candle to the illumination which you see in this great building. Think of it. Twenty-five years as against 200,000 years of intelligent humanity. If you have done so much in 25 years, what will you accomplish in the next 25 years? You will lengthen man's days, you will increase the reading of the printed page, and, by increasing knowledge, build up civilization; and you will satisfy a hunger for more light which has remained unsatisfied since the first human being feared darkness. The hungry eye cries for daylight. The best we can do is shown by this well-lighted building, wherein we give the human eye, in answer to its cry for daylight, perhaps 5-candle power per square foot, while I am told that full daylight is 60. The difference, gentlemen is your field.

In the production of light there is no monopoly. The electrician has no monopoly; the gas man has no monopoly; the manufacturer of candles has no monopoly; the enterprising gentleman who tapped the heart of nature and brought forth oil has no monopoly. Each illuminant has its special field. All are active competitors for the general field; and even the sun is banished where we can produce more pleasing effects by our ingenious utilization of special rays. No; there is active competition, beneficent competition, uplifting competition. The manufacturers of the sources of illumination are no longer selling current, or gas, or oil, or candles. They are selling light. The illuminating engineer must be big and broad, must live up to his profession, must not become a partisan or the paid advocate, and to him will become indebted all the industries which supply light, for until the brilliancy of daylight is reached, the eye hunger will never be satisfied, and the more good light that is given the more the human eye will call for.

We, the great manufacturers of sources of illumination, whether it be the subtle elements which the gas man sends through ramifying pipes to the terminal unit; whether it be the current generated by the whirring dynamo and sent surging through the spiderweb of copper, or whether it be the liquid energy now purified and refined which nature has stored through the ages and which reaches its terminal point in the graceful modern lamp, are coming to realize that each has his field, that all have a common field, that the demand is unlimited, and that we are competing merchants. We are retail merchants, delivering our goods, our products, from door to door in small quantities. We deal directly with the people, and the people will buy where they get the best merchandise. As a result of this competition, light is the cheapest thing in the world. The whole family can be given a long evening of comfort for a penny or two a day, while our grandfathers to produce the same illumination would have used 60 candles. With all our inventive genius, the reaper, the thresher, and the rolling mills, has there ever been much fall in the price of flour? This is but one result of competition. These great manufacturers of illuminating energy are seeking trade, just as the retail merchant seeks trade. The goods are guaranteed. The consumer is greeted as a friend. Behind the little window where the bill is paid, as well as in the office where differences are adjusted, you will find a smiling face and courteous consideration. The public is beginning to understand. The public no longer frantically turns off the light for fear of the day of reckoning. The man who buys light is beginning to deal as fairly with the man who makes it as with any other merchant. The prejudices of the past generation are being wiped out by floods of light.

It is an axiom of the more mature that novelty is too attractive to the young man. It is fortunate for the world that innovation meets approval in the young, for in this direction lies the world's progress; but it might be said that the electrical field, because of an infinite variety, has attracted to it too many young men of the last generation. I might say that the electrical field was overcrowded, were it not for the result of the infusion of so much young blood, so much ambition, so much engineering talent and inventive mentality into electricity, which accounts for the stupendous and amazing growth, in all directions, of this wonderful development of the last few years. It seems as though in this field alone there was room for all, yet I would to-night call attention to the fact that the manufacturer of light by the utilization of gas has a much longer history than other modern illuminants, and undoubtedly, when electricity first sent its radiance to the waiting eye, the gas industry had become, in a sense, an accepted fact, almost commonplace; but the gas industry has awakened, and it, too, has developed marvellously. Aside from the fields of illumination, it has opened new avenues of utility, both domestic and industrial. Many phases of its remarkable progress will undoubtedly cause surprise to many of you, and in our beloved field of illumination you will find that with all the talent which has been utilized in the development of electricity, the gas industry is to-day fully abreast of the progress of the electricians, and, I am almost tempted to say, in some respects ahead in the race. Suppose the gas industry had had the rush of young blood instilled into it at the time electricity was born, where would it stand to-day? Do you think that it is behind where it would have been? I do. Then, gentlemen, it to-day presents a tremendous field for your ambitions.

You have been invited to examine the gas appliance exposition. It is before you. The progress of the industry speaks for itself. This is the fourth exposition of the gas industry held in the world. In 1882 in London the gas industry was for the first time exploited. In New York city, in 1897, America, for the first time brought together in a single

building an exhibition of gas appliances. In London, in 1904, a splendid exposition was held which showed the progress of the English gas manufacturer during the interval of 22 years. The gas appliance exposition now in progress here is the first exposition given in this country since the gas industry has fully awakened to its stupendous possibilities. The entrance of gas into the industrial field is happily well expressed. Its domestic use is exceedingly well exploited, and in your own field of illumination the latest expression of the application of ingenuity and artistic talent to gas is to be found.

I am asked to speak on the progress of the gas industry, and yet my peroration is already on the exposition floor. It is little more than a century since the gas industry was born. I am told that the bowl of a pipe was the first gas retort, that sea coal was the source of the gas, that the bowl of the pipe was heated in the fire and that the resulting gas was lighted at the end of the stem. In this simple arrangement, we have, in theory, at least, the gas industry. It is useless to revert to the prejudices against the invisible substance which makes light, the grave questions which confronted communities as to the unknown dangers which might accompany its utilization, to discuss here the slow development of the proper burner, the gradual application of engineering talent, the detail of constructing light and permanent pipes, the chemistry involved in purification, the problem involved by the expansion of the industry beyond expectation, or the difficulties which the gas man has found in defending his network of pipes from the attacks of the biting current which its electrical brother sends out but to return again.

Electricity was born at a time when the world looked at things with prejudiced eyes. In this field, science followed truth anywhere that she led. The amazing strides of this industry are due to the open mind, but science has also looked upon the gas industry with a clear eye. The prejudices of the past are buried with the past, and as a result of this progress what has the gas industry become ?

I have compiled, and I believe they are presented in their entirety for the first time, some figures which give an idea of the magnitude of the gas industry. The exposition on the floor below shows you those things which are the tools and weapons of its progress, the means by which it holds the appreciation of the world-at-large, but when I tell you what the industry has become, I will make plain to you what is behind this exposition, the plant upon which this flower has blossomed. The total capital invested in gas plants in the United States is $1,600,000,000. This sum would build the Panama Canal four times, would strip Rockefeller and Carnegie of their wealth, and with Morgan added would approximate the value of the gas industry. The sum represents the exports of the United States for a year. " King Cotton " sinks into insignificance with his paltry 600,000,000. Corn, the king of crops, scarcely reaches a parity. I might go on indefinitely to show the magnitude of these stupendous figures. The gas industry serves 38,500,000 people in the United States. Nearly one-half of all the people of the United States are served with gas. When you ask me how they are served, I can answer that there is one gas meter for every 7 people in all this 38,500,000. That is retail delivery for you. That is a house to house distribution. These meters each consume approximately 40,000 cubic feet of gas per annum, and the total output of gas by the gas industry in the past year was close to 200,000,000,000 cubic feet. I will leave the figures as to candle-power hours to the sharp pencils which you clever gentlemen use with such facility, and will leave it to you to establish comparisons. The distance between the bowl of the pipe and the first cubic foot and the present 200,000,000,000 cubic feet per annum represents the progress of the gas industry.

I urge you to look well and understandingly upon the exposition. I know that you will grasp the opportunity which it holds forth with generous hand to the illuminating engineer. I know that you will find an answer to some of your difficult problems. I cannot but believe that some of the young and keenly alert minds which you possess will be induced to add the impetus of your mentality to the gas industry, and, should you do it, I assure you that the field is open and the reward is certain.

REVIEWS, ABSTRACTS, AND REPRODUCTIONS.

A Central Station Illuminating Engineering Department.

(Abstracted from the *Electrical World.* Dec. 26th, 1908.)

The regular meeting of the Boston section of the Illuminating Engineering Society was held at the Edison Building on the evening of December 3rd, when a paper was presented by Mr. H. W. Moses, of the Commercial Illuminating Engineering Division of the Boston Edison Co., on the work of that department since its organization three months ago.

It was with the object of uniting the interests of the architects, contractors, existing and prospective, and the Edison Co., that the division was organized. The company sought by this means to amalgamate forces to produce the satisfied customer. The purpose is to advise and assist customers how to use electricity most efficiently. In presenting suggestions the company has primarily only the customer's interests in mind, as by working along the line that one satisfied customer makes ten new ones, the company expects to offset the decrease in income brought about by the reduced rates and recommendations for greater economy in the use of the current. This was the first company to make a division of this kind.

The scope of the division is broad. It will lay out the entire illumination of any new building, with permission of the architect, and will in like manner undertake the lighting layout in buildings being remodelled. It will, upon application from any existing customer, visit his premises, and after careful consideration of the conditions, submit to him its suggestions for obtaining more light for the same money, or the same light for less money, just as the customer may desire. The company does not always wait for the customer to ask for information, as the agents who are on duty at night are always on the look out for poor and costly installations. These cases are reported directly to the division and reports pointing to greater economy are forwarded to the customer. The collecting division also keeps the department informed of customers who complain that their bills are not right, and of any improvements which seem to be necessary. Further advices are sent in by the district agents, who are daily in touch with customers and conditions in general throughout their districts.

All the work of the division is without expense to the customer. As early as April plans were perfected for the formation of the division and two of the company's experts were sent to Europe to study the latest and most improved methods of illumination. As a preliminary announcement to customers of what the company was about to undertake, a letter was prepared explaining the advantages of the tungsten lamp and sent to every customer from the president's office on June 3rd. On July 15th the company began a series of advertisements in the Boston press relative to the opening of the Commercial Illuminating Engineering Division for the benefit of Edison customers on September 1st. These advertisements, fifteen in all, were published from time to time up to September 1st, and kept the public in touch in a general way with the policy of the division and the progress of the experts who went abroad. On September 1st a letter was sent to every customer announcing the opening of the division for service and soliciting customers' inquiries on matters of illumination. The results of the summer advertising were very gratifying, many congratulatory letters being received, while other companies began to follow the same methods. The company was fortunate in securing the services of so distinguished an illuminating engineer as Dr. Louis Bell to serve as consulting expert. There are four others to attend to the details.

In the working of the division the applications from whatever source they originate are transferred to a small card, together with such information as may be necessary regarding the party to be seen, time of appointment, &c. These cards are duly numbered, and applications are attended to, as far as possible, in the order in which they are received. Spaces are provided on the card to take careful details of the customers' premises, with special regard to size of room, colour scheme, and full details of the present method of illumination, whether gas or electricity, the type of gas-burners in use, also sizes and type of all electric lamps, and kind of shades. All of these data are obtained by an inspector ; a sketch is made show-

ing the present arrangement of fixtures and their relation to each other. Peculiar conditions are carefully noted, as is also the inspector's own impression of the situation. He usually makes no suggestions while on the premises, but simply gets from the customer the viewpoint from which he wishes the matter treated, whether it is desired to obtain more light for the same money or the same light for less money.

A good inspector will on an average make four calls a day. The completed reports are turned into the office every night and reviewed by the consulting engineer as soon as possible thereafter. In the more difficult cases the consulting engineer visits the premises himself and works out the scheme while there, or collects sufficient data for more careful study later on.

A written report is sent to each applicant explaining in considerable detail the changes necessary to bring about the required results. Prices for these changes are sometimes quoted, although, as a general rule, no quotation is given, as the company does not wish in any way to interfere with the business of the wiring contractors. It aims to make its reports clear and to the point, so that the customer can turn the report over to the contractor and receive his estimates in short order.

The division has been a success from the start, over 450 applications having been received during the three months that the work has been under way. More than 400 reports have been sent out, and the balance are in process of investigation. Besides the applications referred to above, there has been a large number of office and telephone calls, which, although pertinent to the subject, required no special report, and thus no records of these calls have been made.

The company has received requests from several parties not in its district, together with plans of new buildings, asking that it lay out the lighting of the building. Checks and money-orders have also been received from parties as far distant as Kentucky, requesting that it ship them some tungsten lamps. The tungsten lamp is a very important factor in the recommendations made by this division. It is giving general satisfaction, and the greatest trouble to date is that the company cannot get the lamps fast enough from the manufacturers.

The tendency in the past to use lamps without shades has proved a rather serious difficulty to overcome, perhaps not quite as serious, however, as to influence the customer to do away with his present type of inefficient shades. The company has made, and is making, careful investigation of the various makes and types of shades that appear on the market from time to time, and its suggestions regarding the use of these are very varied. In the division's best judgment the best shade to produce the desired result is the one recommended regardless of who the maker may be. It is agreed that to produce the best results all lamps require some type of shade, and the question of the proper type is a matter which deserves careful consideration, as many otherwise commendable installations have been spoilt by using improper shades.

In general the use of tungsten lamps is advocated in any place where a Welsbach mantle can be used, as each will stand about the same amount of vibration, while any considerable amount is harmful to both. The flexibility of electric lighting makes it possible to produce some very pleasing and artistic effects by bringing the light very near the objects to be illuminated, as in show-case and window lighting, decorative effects in art-glass shades, domes and portable lamps.

In the case of rearranging existing installations, the ideal condition is rarely attained on account of the expense necessary to bring about the necessary changes. Partial improvements are doing much good, however. Already more than 15 per cent of the reports sent out have been accepted, and the changes completed. Mr. Moses then gave the following classified list of applications received during the past three months :—

Stores	162
Offices	75
Residences	66
Saloons	15
Office buildings	23
Factories	13
Churches	19
Clubs	12
Restaurants	8
Stables	5
Theatres	4
Hotels	3
Bowling alleys	2
Post Offices	3
Banks	2
Libraries	2
Total to date	414

The company has been especially pleased with the way the churches have applied to it for advice. This business is good, in spite of the fact that the income is comparatively small. A large percentage of all applicants desire lower

bills; some want better light regardless of cost, and others want better light at the same cost. The division hopes especially to co-operate with the architects and make them see the fallacy of the general use of wall-brackets, for example, in residence lighting. Bracket lighting is extremely costly.

On Dec. 1st, 1908, the company had sent out 8,066 25-watt, 6,997 40-watt, 6,737 60-watt, and 11,476 100-watt tungsten lamps, or a total of 33,276 lamps, which, Mr. Moses stated, is more than the combined total of all the large Edison companies of the country.

An extended discussion followed the paper. Mr. Moses stated that the company's connected load in 16 candle-power equivalents is greater to-day than ever before. The company's lamp team calls on every customer on the average of once in seven weeks, and leaves 20 per cent of the installation in spare lamps. Larger customers are visited oftener. The attitude of the company toward the substitution of the tungsten for the arc lamp is favourable in suitable cases. In the best example of clothing store lighting in Boston, 2-, 3-, and 4-light 100-watt tungsten clusters have superseded arcs. The company is now frequently recommending angular and vertical lighting by 25-watt tungsten lamps, and experiments are being made as to the possibility of operating these lamps successfully in a horizontal position. This has an important bearing on the lighting of store-windows. The company is not recommending the general use of 250-watt tungstens, and has put out only eleven of these to date. The cost of the lamp is great, and the renewals are consequently expensive. There is not as good economy of illumination as with four 100-watt lamps, and the latter often can be cut off in part at certain times of the day to offset their greater combined first cost. In general, a 500-watt arc is replaced by a 4-lamp cluster, of 400 total watts. The tungsten lamp is beginning to take hold of industrial service, the question of vibration being the main issue at present. In one case this has been prevented by catching a loop in a cord carrying a 60-watt tungsten unit, and in another by suspending the lamps from a cord stretched across a factory room.

Motor Cab Lighting.

A CORRESPONDENT, in a letter to a recent number of the *Daily Mail*, points out what he considers several defects in systems of charging fares on the part of drivers of motor cabs, laying special stress on the fact that the dials, indicating the fare, are not adequately illuminated by night; on one occasion he had a difference of opinion with the driver on the subject of the fare, and on striking a match to illuminate the dial, found that the man had apparently taken advantage of its obscurity by charging too much.

Seeing that motor cabs are probably so extensively used by night the necessity for special arrangements in order to enable the dial to be seen seems evident; this is one illustration of the many points to which an "Association of Car Lighting Engineers," as mentioned in our January number of this year, might fitly deal.

Imitation of Candles in Electric Lighting.

IN an article contributed to *The Illuminating Engineer* (January, 1909, p. 41) a correspondent commented upon the tendency to use modern methods of producing light, and yet to imitate the relatively feeble illuminants of the past. The imitation of candles by means of small metallic filaments is a case in point.

In this connexion our contemporary *The Builder*, commenting on the matter, remarks: "As far as this journal represents architects, we can assure the writer that the imitation of candles in electric lighting is a silly and absurd sham, with no artistic principle of any kind to recommend it."

This definite expression of opinion is in accordance with the views stated by Mr. E. L. Elliott and others in the discussion of a recent paper by Mr. W. Basset Jones, before the Illuminating Engineering Society in the United States (see *The Illuminating Engineer*, London, May, 1908, p. 412).

Lighting a Shop with High Candle-Power Tungsten-Holophane Units.

Fig. 2.—Shop lighted by 100 watt tungsten lamps, with holophane reflectors, Worcester, Mass, U.S.A.

In one of the most recent publications of the Holophane Co., some interesting particulars are given of the use of high candle-power combined tungsten-holophane units in place of arc-lamps. In the United States 100-watt and even 250-watt tungsten lamps seem to be coming into use for lighting large premises. An instance in point is the substitution of 100-watt tungsten lamps, in holophane bowl reflectors, for the nine $5\frac{1}{2}$ ampere arc-lamps formerly employed in the illumination of the National Cash Register Co.'s showroom in Chicago.

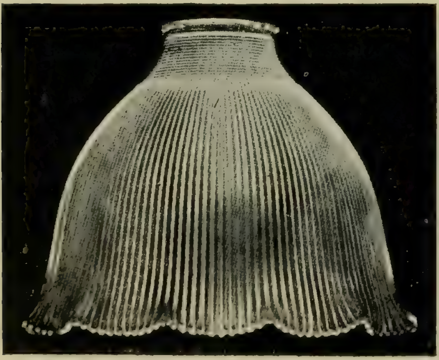

Fig. 1.—Holophane bowl reflector for use with 250 watt tungsten lamp.

Naturally the use of these high units necessitates special care in order to shield the eyes as well as to distribute the light to the best advantage, and it is therefore becoming customary to sell the lamp with its corresponding diffusing shade as one unit. A new form of holophane bowl reflector, for use with the 250-watt tungsten lamp, is shown in Fig. 1.

Fig. 2 also shows the application of fixtures of this class to the lighting of a prominent shop in Worcester, Mass., in the United States, by 100-watt bowl-frosted tungsten lamps with crimped holophane reflectors. In this case, it is interesting to observe, the owners of the shop did not desire to reduce their lighting bill, but preferred to obtain nearly four times the former effective illumination at the same cost.

A New Form of Shadow Photometer.

At a recent meeting of the Elektrotechnische Gesellschaft zu Cöln, Herr Lantsch described a new form of portable shadow photometer brought out by the Land und Seekabelwerke Aktiengesellschaft of Cöln-Nippes.

The photometer is not intended to compete with the existing accurate types of "Precision photometers," but constitutes a handy and portable arrangement for the comparison of glow-lamps; it is, however, claimed that measurements can be carried out with an exactitude amply sufficient for practical purposes, namely, within 5 per cent.

The general nature of the instrument will be understood from Figs. 1 and 2. In Fig. 1 the box in which the photometer is fitted is shown open. The observer looks from without, at the opal glass screen A. The two lamps to be compared are firmly fixed in the porcelain holders C and D, one of the two lamps G being a standard of known intensity. An arrow is etched on the bulb of this lamp, indicating the direction in which the specified standard intensity is emitted, and the lamp is adjusted so that this arrow faces the direction of measurement. A sheet of frosted glass M is inserted in front of the two lamps, and serves partially to diffuse the light and to avoid the formation of bright "streaks," due to effects of reflection and refraction in the bulbs of the lamps tested. The screen B is placed behind the sources of light, so as to prevent their dazzling the eyes of the observer.

The rod E throws two shadows upon the screen A on the Rumford principle. In this instrument, however, this shadow-object E is moved to and fro parallel to the surface A, and the lamps are kept stationary. This lateral movement tends both to increase the distance of one lamp from its shadow and to decrease the distance of the other, and also to alter the inclination at which their rays strike A. A position for E can thus be found so that the two shadows appear equally dark, and it would be possible to calculate the ratio between the

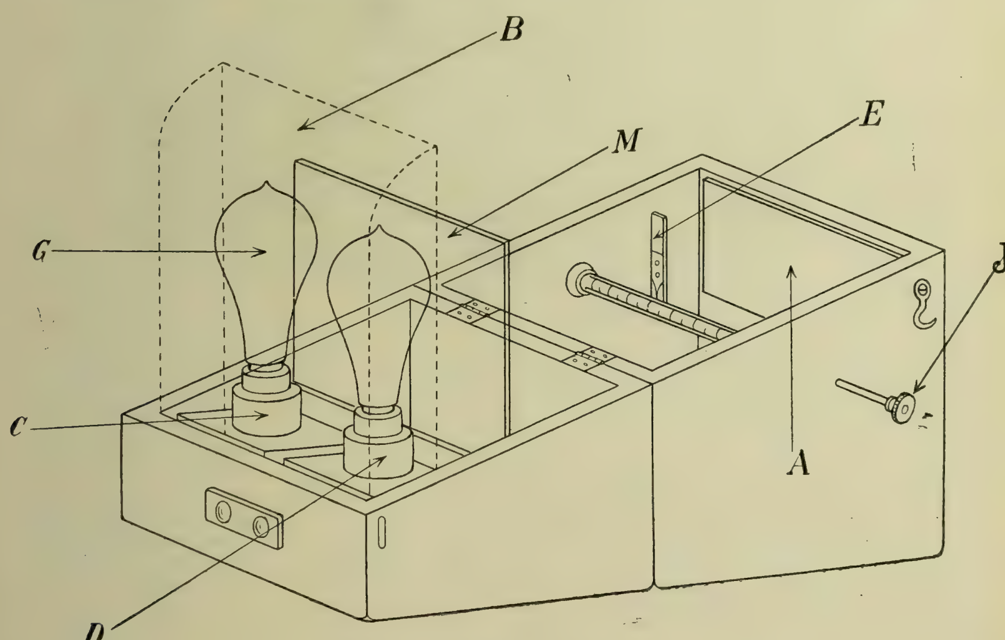

Fig. 1.

intensities of the two lamps on the assumption that they were point-sources. Actually, of course, this is not the case, and it is therefore necessary to ascertain the values corresponding to the various positions of the shadow-rod E by experimental calibration. A scale is thus obtained graduated in c.-p. of the lamp tested in terms of the standard. Interchangeable scales are provided calibrated for candle-powers of 10, 16, &c.

By means of a short length of flexible wire the two lamps are plugged on to the source of P.D. available, in parallel.

As far as the candle-power of a lamp is concerned it is unnecessary to know the actual value of the P.D. provided, since the candle-powers of the standard and lamp tested are affected by any change in the pressure, in exactly the same way; to this end the standard lamp must be of the same type as the lamp tested, *e.g.*, both must be carbon, or both metallic filament lamps. Standard lamps supplied with the photometer are "aged" for about thirty hours before use. Small ammeters and voltmeters for use with the apparatus, to determine the power taken by the lamp studied are shown in Fig. 2. In other models of the apparatus an ammeter and voltmeter are included fixed in position within the box containing the photometer.

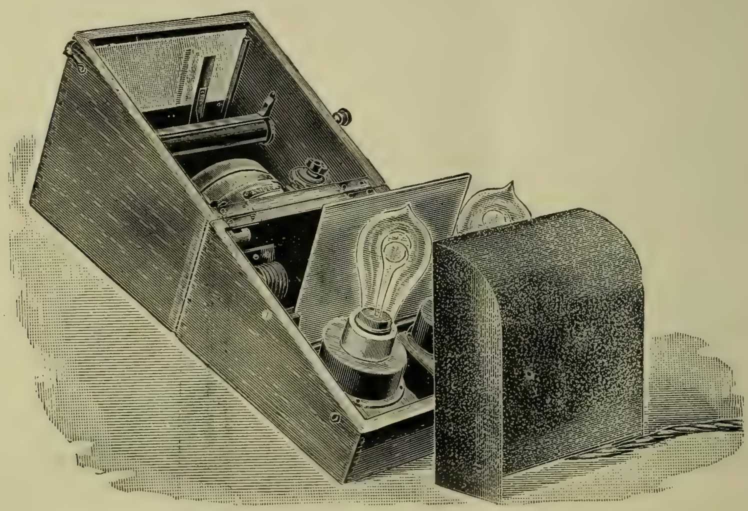

FIG. 2.

The instrument enables all lamps to be tested, provided the c.-p. does not vary more than ± 25 per cent from that of the standard. We can thus conveniently determine whether or not a lamp falls below the permissible value of 80 per cent of its specified candle-power, by merely placing the rod at the corresponding position of the scale and observing whether or not the difference in shadow is in the right direction.

Iron and Steel Institute.

THE ANDREW CARNEGIE RESEARCH SCHOLARSHIP.

A RESEARCH SCHOLARSHIP or scholarships, founded by Mr. Andrew Carnegie (past President), is awarded by the Council of the Institute, irrespective of sex or nationality, to suitable candidates under thirty-five years of age, who must apply for a special form before the end of February.

The object of these scholarships is to enable students, having satisfactory acquirements and training, to conduct researches in the metallurgy of iron and steel, &c. There is no restriction as to place of research, provided it be properly equipped for the investigations.

The scholarship is available for one year, but may be renewed at the discretion of the Council. The results of researches will be communicated in the form of a paper before the Institute. If of sufficient merit the Andrew Carnegie Gold Medal will be awarded to the author.

All particulars from G. C. LLOYD Secretary, 28, Victoria Street, London.

The Mechanical Equivalent of Light.

By J. S. Dow.

(Abstracted from *The Electrical World* of New York, Dec. 12, 1908.)

In this article the author contributes a résumé of recent articles by Dr. C. V. Drysdale, Dr. H. Lux, and others,* and proceeds to discuss the variation of the "mechanical equivalent" in different parts of the spectrum. In one sense, a source that produced all its effective radiation within the visible region of the spectrum might be said to possess an efficiency of 100 per cent. Yet we know that different parts of the spectrum vary very greatly in luminous efficiency, owing to the preference of the eye, which is most sensitive to the central region.

Any attempt to determine the mechanical equivalent exactly is limited by the peculiar physiological complexity of the eye, by reason of which it would seem that the quality of light that is most effectual at high illuminations is not so when the intensity is low. Thus the writer suggests that though, at high illuminations, above say 10 foot-candles, light near 0.59μ is most useful, we ought, presumably, to use a source rich in radiation near 0.525μ in order to get the best results when the intensity cannot exceed about $\frac{1}{100}-\frac{1}{10}$ of a candle-foot.

On the assumption that we are concerned with high illumination, the author proceeds to map out the values of the mechanical equivalent throughout the spectrum, by calculation from Dr. Drysdale's result for light near 0.54μ, and the curve of luminous efficiency for the solar spectrum. The highest value deduced is about 27.5 candles per watt, near 0.59μ, and practically all the light of any luminous value is concentrate between 0.45μ to 0.7μ.

An interesting side-issue raised by the author is how far the above results, determined for portions of the spectrum *considered separately* are applicable to the total integral luminosity. Supposing for instance, we produce a red patch and a green patch of light, and then superimpose them and get white, do the separate brightnesses of the patches add up to make the brightness of the white ?

This question has been answered in the affirmative by certain physiological and physical workers of great repute, but the new developments in physiological optics would lead one to suppose that this is not invariably the case. In addition to that there are several recorded experiments on the practical photometry of the combined illumination of carbon filament electric glow-lamps and mercury vapour lamps, that point to an opposite conclusion. On all these physiological points further data are needed.

**Illuminating Engineer*, Feb. and Aug., 1908.

Tests on Tungsten Lamps.

We have received an intimation from Mr. Lancelot Wild, chief electrician to the Westminster Electrical Testing Laboratory, regarding a series of life testston ten of the principal makes of Tungsten filament lamps, the result of which tests will be supplied to subscribers only.

The following are the names of the lamps tested :—

Aegma.—The Electrical Co.
E.M.F.—E.M.F. Manufacturing Co.
Sunbeam.—Sunbeam Lamp Co.
Adnil.—Marples, Leach & Co.
B.T.H.—British Thomson-Houston Co.
Sirius.—Falk, Stradelmann & Co.
Westinghouse.—British Westinghouse Elect. and Mfg. Co.
Osram.—General Electric Co.
Metfil.—Edison & Swan Electric Light Co.
Gabriel.—Gabriel Electrical Lamp Co.

Four lamps were tested of each make. The lamps were all obtained direct from the above-named firms, this being the only way at present of obtaining them with certainty. The lamps were all ordered as for 100 volts and of 25 to 30 mean horizontal candle-power, with the exception of the B.T.H. lamps, which were rated at 40 candle-power.

The lamps were run on 100 volts for a period of 1,000 hours, and were tested for *mean spherical* candle-power watts and watts per candle-power at start and afterwards every 200 hours. The voltage during the run was maintained constant to within half per cent by means of an automatic regulator.

The subscription required to obtain one copy of the complete report is £2 2*s*. Additional copies may be obtained (for personal use only, and not for resale) at £1 1*s*. each.

Fund for Mrs. B. H. Thwaite and Young Children.

In this number we make room for the appeal on behalf of the widow and children of Mr. B. H. Thwaite, briefly referred to in our last.

The long painful illness which preceded his end involved heavy expenses he could ill afford, and his widow has collapsed under the added burden of the final shock, and is unable to face the future without substantial succour for herself and her two young children—a boy of eight and a delicate girl of fifteen respectively.

The circumstances of the case were laid by some friends before Mr. Carnegie, who, with characteristic generosity, has promised the sum of 500*l.* conditionally on a like sum being subscribed by others. The following gentlemen have, therefore, formed themselves into a preliminary Committee, and other influential and representative names are daily being added to the number of the Committee or sympathizers.

A few words of appreciation of Thwaite must be said, to indicate why a ready and generous response should be made to the call of his family in distress.

Over 200 patents lodged by him attest in a concrete form some of the workings of his busy brain, but his thoughts comprehended a range of subjects astonishing to the average mind. The honour of being the first to prove that waste blast furnace gas could be utilized in the cylinder of an internal combustion engine is his absolutely.

It might be said that here is a striking case of brain energy multiplied into an infinite sum of mechanical energy; and some of us who realize from the strides made in other countries what it will some day mean in our own, feel proud that another British name has been added to those whose labours have pointed the way to further economy in our great iron-producing industry, simultaneously creating a new field for large gas-engines and electrical enterprise.

The latest available figures show that one firm of large gas-engine builders alone have built, since 1902, or have in hand, 247 engines aggregating 308,000 horse power, and in Germany alone the power now generated by blast furnace gas in gas-engines cannot be far short of one million, if indeed it does not exceed that figure. In Belgium also there have been great developments; also in the United States, where one works alone—the Lackawanna Iron Co. — have some 45,000 horse-power of blast furnace gas-engines at work.

Great Britain has lagged somewhat behind, but there is now steady progress being made towards the realization of Thwaite's hopes, which in Germany have been more than realized.

Thwaite reaped no adequate monetary reward from the patents he took out, and his attempt to build up a business by supplying plants was made in the face of appalling difficulties. Gas-engines of even 200 horse-power were rare, due to the existing limitations of town and producer-gas; and having no works, he was ill-equipped to rectify the mistakes in design inevitable in the first serious engine units he contracted for. When English and foreign firms, having every resource of capital and workshop equipment, also experienced many costly failures in their early installations, in justice to Thwaite his far greater handicap must be realized. The financial support he received was altogether insufficient to cope with his task, but was generous when considered as given by one man, Mr. F. Gardner, who incidentally was neither an Englishman nor a technical man. But the progress, since made is a triumph for all who have been concerned in building up the business to its present colossal proportions.

The Committee, therefore, appeal to engineers and business men to come forward promptly in order to provide the funds necessary for Mrs. Thwaite's immediate and urgent needs, and to bring up and educate the two young orphans. They are anxious to make an early demand upon Mr. Carnegie's conditional promise.

W. M. Mordey, M.Inst.C.E., Pres. Inst.E.E.
W. H. Preece, Sir, Past Pres. Insts.C.E. and E.E. F.R.S.
A. B. W. Kennedy, Sir, Past Pres. Inst.C.E. F.R.S.
Robert Kaye Gray, M.Inst.C.E., Past Pres. Inst.E.E.
J. O. Arnold, Professor of Metallurgy, Sheffield.
Harold Jeans (*Iron and Coal Trades Review*).
H. Alabaster (*Electrical Review*), 4, Ludgate Hill, E.C.
T. E. Gatehouse (*Elec. Review*), A.M.Inst.C.E. M.Inst.M.E. and E.E. F.R.S.E.
A. M. Sillar, M.Inst.C E. M.Inst.M.E. M.Inst E.E., Hon. Treasurer, 2, Queen Anne's Gate, S.W.
Hon. Secretary: W. H. Booth, M.Am.Soc.C.E., 2, Queen Anne's Gate, Westminster, S.W.

CORRESPONDENCE.

Illuminating Engineering Qualifications.

Dear Sir,—I have read with much interest an article appearing in your esteemed paper, *The Illuminating Engineer*, by Mr. Charles W. Hastings, entitled 'Artificial Illumination and the Education of those Concerned in its Production.'

I wish, first, to congratulate Mr. Hastings on his efforts, in collaboration with yours, to establish the basis of information or knowledge necessary for the practice of illuminating engineering, because there is to-day a wide diversity of opinion on the qualifications necessary for an illuminating engineer to possess in order to carry out his work intelligently. Second, to endeavour to supplement Mr. Hastings's efforts by offering further suggestions in this general direction.

To my mind, the intelligent use of artificial light, which, when all is said and done, is illuminating engineering, consists, first, in giving due consideration to the physiological and hygienic sides; second, the æsthetic, the use of illuminants in a manner calculated to produce harmony; third, the technical and theoretical, which exists chiefly in the laboratory; and, fourth, but by no means last, practical knowledge—that knowledge which is gained by experience; such experience being the results of systematically directed efforts.

It has been my experience in observing the methods of work employed by persons having to deal with lighting matters, to note that there is oft-times a decided tendency displayed to consider the technical (mathematical) side of the work as being the most, and, in some cases, the all important. There are persons who, in designing lighting systems, are seemingly lost unless they can work out elaborate calculations from photometric curves, which show them *theoretically* what the variation and intensity of illumination will be in a given space. But values thus obtained give but little idea as to what will be the *effect of light on the eye*, which is a point of *considerable* importance. It does not follow that because we *theoretically* obtain a given distribution and intensity of illumination, that the same will be satisfactory to the eye, either from a physiological or æsthetic standpoint. Therefore, *something more* than mathematical formulæ must be considered, although I appreciate their usage in the work as a whole.

Photometric curves, even reasonably well obtained, while being of considerable assistance, are not necessarily the all-important thing to be considered, inasmuch as they are not without errors, and oft-times very grave errors. Therefore, their use can only be considered as something to give reasonably close, but not *accurate* results. This fact, I think, is appreciated by most persons having to do with the making of such curves, and by some persons who have to use such curves in actual practice. They are, to my mind, but one of *several* means that one must employ to accomplish desirable results. Such results can oft-times be obtained by intelligent approximation, thus considerably facilitating one's efforts by greatly eliminating elaborate calculations. The practice of approximating, however, should only be resorted to when the proper foundation — experience — has been established. I cannot too forcibly bring out the necessity and great value of having knowledge gained by practical experience. In the experimenting work necessary to obtain such ex-

perience, many idealized theories will be almost totally destroyed, for in no branch of work, in my opinion, is there such a wide difference between theory and practice.

It should be borne in mind that to be a *competent* illuminating engineer—it is unfortunate that this title has been, in some cases, assumed by persons whose knowledge of the subject as a whole is somewhat meagre, and who, therefore, in some degree retard its recognition—one must not only have knowledge of the part that electricity plays, but also the value of such agencies as gas, acetylene, gasoline, &c., for without such knowledge one is unable to establish a most important thing—namely, comparison. Lack of such knowledge is oft-times in evidence in articles dealing with matters pertaining to light, where it may be noticed that the persons writing such articles apparently have studied only the functions as performed by one of these agencies. Comparisons thus cited may show considerable prejudice for one illuminant, and, of course, a lack of knowledge of the other.

Illuminating engineering is generally referred to as being related both to science and art. I have oft-times defined it as being "a science in the laboratory and an art in its application."

I sincerely trust that the day is not far distant when a definite basis for illuminating engineering will be established and generally recognized, for it certainly has a place in the profession as a whole, and in establishing the basis for its existence the many branches with which it deals should be considered. Yours very truly,

A. J. MARSHALL.

Chief Engineer of the Bureau of Illuminating Engineering, New York.

London Electric Supply.

WE have received from Mr. A. A. Voysey a long letter dealing with the above question. We regret that space does not enable us to reproduce this *in extenso* on this occasion; but the following extract may serve to indicate the nature of his suggestions regarding the improvement of present conditions.

Briefly, Mr. Voysey contends that electric lighting is hampered by the needless multiplication of supply undertakings and apparatus, and consequent fierce competition, and waste where co-operation, would be more desirable. Such a condition of things, once established, can only be remedied by degrees. Mr. Voysey, however, asserts that the vast sums of money that are being, and have been, expended in attempted legislation have had little or no beneficial influence. The real problem consists in inducing undertakings to combine with a view to economy, to adopt improved and efficient machinery, and to endeavour to establish some degree of standardization so as to render mutual help and dependence possible.

But there still remains the very vital question of the relations of competing gas and electrical undertakings. We may quote in detail Mr. Voysey's suggestion for their amelioration :—

"If we suppose for a moment that there is no electric or gas supply in London, and consider how, in view of existing knowledge, we should light, heat, and give power to London, we should arrive at the general conclusion to supply for heating a gas of high calorific value (which would incidentally tend to solve the smoke problem), the gas being of much cheaper grade than that now supplied for lighting. With the residue of the fuel from which this gas was made we should make power-gas and general electricity, to be used in metal filament and flame-arc lamps for lighting, and in motors for power where direct use of the gas in engine or boiler was not convenient or economical. No gas would be made or used for lighting.

Information easily obtainable by any engineer will show what a vast saving could be effected in the present cost of heating, lighting, and power, by the adoption of such a scheme as that suggested. Then why cannot the gas companies agree to give all their consumers to the electric supply companies on the condition that the latter will buy power-gas or electricity in bulk from them ?"

Lux or Meterkerze?

Dear Mr. Gaster,—On page 65 of the January number of *The Illuminating Engineer* for the present year, Prof. Weber contests my opinion that the figures given by Cohn for the hygienically correct minimum illumination are not 10 and 50 Hefnermeterkerzen respectively, but must be corrected on account of the fact that, at this time, the Hefner unit of light was not in use.

In my book entitled 'Elektrische Beleuchtung,' 1906, I have already given the figures 12 and 60 lux (Meterkerzen), for these values of Cohn; Prof. Weber, however, contends that these results were determined on the basis of the Hefner unit, and that no correction is therefore necessary.

On the other hand I maintain that in the fundamental work of Prof. Cohn on this subject 'Ueber den Beleuchtungswert der Lampenglocken' (published by J. F. Bergmann, Wiesbaden, 1885), in which the recommended hygienic minima of illumination are set down on p. 72 as 10 and 50 meterkerzen respectively, but one single proposition relating to the nature of the unit of light on which these measurements are based occurs, namely that expressed on p. 4 in the following words :—

"It (*i.e.*, the brightness of a white surface) amounted to 14.7 Spermaceti-candles (standard candles), according to the results of Weber and myself, which agreed well with one another. In this case the standard candle at one metre's distance is also a meterkerze."

In other parts of the work, mention is made of "kerzen" and "meterkerzen."

There can, therefore, be no doubt that in this work the Hefner unit did not form the basis on which results were expressed, and, as the spermaceti candle=1·14 hefner candles, the minimum illumination recommended, becomes, according to the method of reckoning in use in Germany at the present time, not 10 to 50 Hefnermeterkerzen, but 11·4 to 57, or, in round figures, 12 to 60 Hefner-Meterkerzen. With best wishes, I remain

Yours sincerely,

Dr. Monasch.

Sehr geehrter Herr Gaster!—Auf Seite 65 des vorliegenden Jahrganges vom *Illuminating Engineer* (Heft Januar, 1909) tritt Herr Prof. Weber meiner Ansicht entgegen, dass die Cohnschen Zahlen für das hygienische Minimum der Beleuchtung nicht 10 und 50 Hefnermeterkerzen sind, sondern umzurechnen sind, da bei ihrer Aufstellung nicht die Hefnerkerze als Lichteinheit verwendet wurde.

Ich gab schon in meinem Buche, 'Elektrische Beleuchtung,' 1906, für diesen Wert von Cohn die Zahlen 12 und 60 Lux (Hefnermeterkerzen) an. Herr Prof. Weber hingegen behauptet, dass die Cohnschen Zahlen under Zugrundelegung der Hefnerkerze gewonnen worden sind und daher keiner Umrechnung bedürfen.

Demgegenüber stelle ich fest, dass sich in der grundlegenden Arbeit von Prof. Cohn, 'Ueber den Beleuchtungswert der Lampenglocken' (Verlag von J. F. Bergmann, Wiesbaden, 1885), in welcher auf Seite 72 die hygienische Minimalforderung von 50 bezw. 10 Meterkerzen formuliert ist, eine einzige Aufgabe über die den Messungen zu Grunde liegende Normaleinheit der Lichtstärke befindet und zwar lautet auf Seite 4 wörtlich :—

"sie (Die Helligkeit einer weissen Flache), betrug nach Webers und meiner übereinstimmenden Messung 14.7 Spermacetikerzen (Normalkerzen). In diesem Falle bei 1 M. Entfernung ist die Normalkerze zugleich eine Meterkerze M.K."

In den weiteren Teilen der zitierten Arbeit wird immer nur von Kerzen und Meterkerzen gesprochen. Es kann also keinem Zweifel unterliegen, dass in dieser Arbeit nicht die Hefnerkerze den Messungen zu Grunde lag und da die Spermacetikerze=1·14 Hefnerkerzen ist, waren nach heutiger in Deutschland üblicher Rechnungsweise die Minimalwerte nicht 10 bezw. 50 Hefner-Meterkerzen, sondern 11·4 und 57 oder rund 12 und 60 Hefnermeterkerzen. Mit bestem Grusse bin ich Ihr

sehr ergebener,

Dr. Monasch.

Lux or Meterkerze ?

Dr. Monasch originally expressed the view that the word *Meterkerze* ought to denote that illumination which would be produced by an old German *Vereinskerze* at a distance of 1 metre. Certainly, if one were to accept this restricted meaning of the word, it could no longer be applied at the present time. But this impression of Dr. Monasch is based on a misunderstanding. By *Meterkerze* Prof. Cohn and I have always intended to be understood, that illumination which is produced by a *unit of light*, at a distance of 1 metre.

The misunderstanding has clearly arisen through the fact that we frequently denoted the unit of light by the word *Normalkerze* (standard candle), while Dr. Monasch—incorrectly—has applied this word to describe the old German *Vereinskerze.*

To clear this matter up I have maintained (*Illu. Eng.*, vol. ii., Jan., 1909, p. 65) that Prof. H. Cohn never made measurements in terms of the *Vereinskerze.* These facts are consistent. On the other hand, the further statement on my part that Prof. Cohn always and only measured in Hefner units should be modified, for he originally did use spermaceti candles, and only subsequently utilized the Hefner.

The passage quoted by Dr. Monasch from the work of Prof. Cohn really means : "If a surface is illuminated by 14·7 units of light, at a distance of 1 metre, the above figure also represents the intensity of illumination in 'Meterkerzen.'" (Signed) L. Weber.

Herr Dr. Monasch hatte ursprünglich die Ansicht vertreten, dass das Wort "Meterkerze" diejenige Beleuchtungsstärke bedeuten solle, welche durch eine alte deutsche Vereinskerze in 1 met. Abstand entsteht. In der Tat, wenn man diese ganz speciele Bedeutung annehmen wollte, so könnte das Wort Meterkerze jetzt nicht mehr angewandt werden. Allein dieser Auffassung des Herrn Dr. Monasch lag ein Missverstandnis zu Grunde. Unter Meterkerze haben Prof. Herm. Cohn und ich stets diejenige Beleuchtung verstanden, die von der *Lichteinheit* in 1 met. Abstand erzeugt wird.

Das Missverstandnis ist offenbar dadurch entstanden, dass wir die Lichteinheit vielfach als Normalkerze bezeichneten, während Herr Dr. Monasch dies Wort Normalkerze fälschlich auf die deutsche Vereinskerze bezogen hat.

Zur Auf Klärung hatte ich (*v. Illu. Eng.*, Jan., 1909, s. 65) behauptet, dass Herm. Cohn niemals nach Vereinskerzen gemessen habe. Diese Tatsache bleibt bestehen. Dagegen ist der von mir weiterhin hinzugefügte Satz, dass Cohn stets nur nach Hefnerkerzen gemessen habe, dahin zu verbessern, dass Cohn im Anfange seiner Messungen nach Spermacetikerzen und erst später nach Hefnerkerzen gemessen hat.

Der von Herrn Dr. Monasch in vorstehender Mitteilung citierte Satz aus dem Cohnschen Werke bedeutet : "Wenn eine Fläche in 1 met. Abstand von 14·7 Lichtstärke-Einheiten beleuchtet wird, so gibt diese Zahl zugleich die Beleuchtungsstärke in Meterkerzen an. (gez.) L. Weber.

Sir William Preece kindly sends us a copy of the paper communicated by him to the Royal Society in 1883 (*Proc.* Royal Soc., No. 229, 1884), in which his proposition regarding the "lux" was put forward, accompanied by some account on the consideration leading to this suggestion.

It is interesting to observe that even at this early date the need for a unit of intensity of illumination was realized. For instance, the author remarks :—

"An absolute standard of light has not yet been obtained. I have long felt that, to meet the case of electric light illumination, we must not depend upon any direct comparison between the light emitted by the source to be measured and any given recognized standard of light; but that we should rather make our standard of comparison of area illuminated to a given intensity, whatever be the source of light. We do not want to know so much the intensity of the light emitted by a lamp as the intensity of illumination of the surface of the book

we are reading, or of the paper on which we are writing, or of the walls upon which we hang our pictures, or of the surface of the streets and of the pavements upon which the busy traffic of cities circulates. Illumination of this character depends not on one source only, but on many sources of light distributed in innumerable ways. Hence I propose to measure the illumination of surfaces quite independent of the sources of light by which they are illuminated....The standard I propose is the space illuminated by one British standard candle at 12·7 inches distance, which is the same as the illumination given by one French standard 'bec' on the same space at 1 metre distance."

And again :—

"The principle of measurement which guides us in nearly all the methods at present in practical use is to compare two surfaces equally illuminated to the same intensity by lights placed at different distances, and to compare them by the law of inverse squares determined by Kepler. This law, however, assumes a clear space through which the light is transmitted, and the emission of this light from point. Distance therefore becomes essential, and the error introduced by large flames or by the diffusion of light becomes difficult to eliminate; indeed, by the present system it is well-nigh impossible to measure satisfactorily the light-giving power of several lamps distributed over a room or large area."

Sir William, in the paper referred to, then proceeded to point out some of the difficulties involved in the measurement of illumination, many of them, such as the choice of a suitable standard of light, familiar to us to-day. A portable illumination-meter, however, has the advantage that it need not contain the actual standard as part of the apparatus, but can be calibrated in the laboratory, and subsequently carried out into the streets or on board ship, &c., as circumstances may require.

In 1883, Sir William states, when this paper was written, the Hefner did not exist; the only Continental standard in use was the French "bec" or Carcel, and the proposed Lux, defined as above, was an endeavour to assimilate the Continental and English units. At the present day the matter is more complicated. We have many standards in use, all in some degree unsatisfactory.

What is still badly needed in order to simplify this confusion is, as Prof. Weber states, agreement on an international unit of light.

Daylight Illumination.

Dear Sir,—I have read with great interest Mr. P. J. Waldram's comments on this subject in your January number.

I must confess that common experience does not suggest that there is any very enormous or marked difference in the point at which the illumination becomes too weak to read by with comfort in the case of diffused daylight and artificial light respectively.

For instance, on Jan. 5th, when the sky was a uniform white in appearance the illumination at 10.45 A.M. on a table placed beside the window of my office was about 530 Hefner-Lux, while that on a desk about 12 feet from the window was only about 9 Hefner-Lux, *i.e.*, slightly under 1 candle-foot. Yet it was still quite possible to read, though not exactly with comfort; this, I believe, is also common experience with artificial light.

On the other hand, the illumination of 530 Hefner-Lux, *i.e.*, about 53 candle-feet, though far greater than that usually employed in artificial lighting with comfort, did not seem in the least glaring, and this value is probably often vastly exceeded by those met with under daylight conditions in summer.

There does seem, therefore, reason to suppose that, in the case of diffused daylight illumination, the eye is capable of standing a higher illumination than would be considered pleasant when the ordinary methods of artificial lighting are adopted, and it is an interesting problem for the physiologist to determine exactly why this should be the case.

I am, yours truly,

Athos.

The Internal Lighting of Churches.

2, Great Smith St., Westminster, S.W.
January 22nd, 1909.

SIR,—The series of articles which appear in your January number on Church lighting, open up a most interesting subject, but I confess to having read them without coming to any very definite or fresh conclusions on the subject.

As an architect may I be allowed to say that I think the engineer had better give up the "artistic" side of the question and devote himself entirely to the practical. A well-designed building will look well, or shall I say well enough, under almost any conditions of artificial lighting; it is the congregation that should be thought of and not the building, which of necessity is designed to look its best by daylight and at its very best, with not too much of that.

From the humorous reference to the interior of Cologne Cathedral being represented by an absolute blank—if not taken too seriously—a good deal might be learnt by the illuminating engineer, for few things are more impressive than the sombre interior of a great cathedral. Take Westminster Cathedral as an example: even plain stock brickwork looks well there, when it cannot be seen properly. Light the building like a gin palace and it will probably look hideous. Mystery and imagination are the two greatest aids to architectural effect, and the arc-lamp perhaps its greatest enemy, but let us get back to the congregation; for whom after all the Church was built.

In the daytime the light naturally comes in through the windows, and in an old building where the walls are thick it is surprising how few of these can be really seen by the congregation, unless they are looked for. The east window is the only real offender, and for this reason amongst others it is nearly always filled in with stained glass. It will be seen, therefore, that most of the light gets into the building without our quite knowing how, and omitting the east window it all comes from behind or either side of us, and if this principal could be followed in artificial lighting it would probably be the most satisfactory; but in the case of the side lights, they themselves must not be visible as artificial light, being so much more concentrated than ordinary daylight, is for that reason more objectionable if unmasked.

However, wherever the light is placed I think we might almost begin with this rule, that it must not be itself seen under ordinary circumstances *i.e.*, when the congregation is in its ordinary place. A general diffused light over the worshippers coming from unseen points is the ideal to be aimed at, and the nearer we get to this the greater will be the comfort of the congregation. Of course if there is a fine reredos or altar-piece this might be specially lighted by light thrown on it, again from some concealed point; but to light up every tomb or other interesting object by the same means would tend, in my opinion, to turn a place of worship into a museum. In the daytime such objects keep their own place, but if "illuminated" I fancy they will look incongruous.

And now, Sir, I have expressed to you my crude ideas, perhaps some other correspondent who has more thoroughly thought out the subject will put me right where I am in error.

Yours truly,
LEONARD STOKES.

DEAR SIR,

I have read with interest the courteous criticisms passed by Mr. Stokes on my article in the letter kindly submitted to me for reply, and hope to make some remarks on the subject in your next number.

I am, yours truly,
AN ENGINEERING CORRESPONDENT.

The Internal Lighting of Churches.

I looked,
And in the likeness of a River, I saw Light flowing.

Dante, 'Paradiso,' xxxi.

SIR,—I am extremely glad to see, through your excellently edited journal, that a discussion about such an important question as the illumination of churches is now arising in England, and I am indebted to you for directing my attention to this "burning" question.

It has been remarked that church-lighting deserves very careful consideration, which is due "partly to the architectural arrangement of the places of worship, partly to the demands of traditional ritual, and partly to the persons to whom it is intended to appeal."

I will pass over the question whether the systems of Inigo Jones, Christopher Wren, or Vanbrugh, or the Byzantine or Renaissance or Basilica architectural style would be in sympathy with the illumination obtainable from modern sources, even though "imitating the relatively feeble ancient devices." I quite concede the fact that, as far as light is concerned, the Italian style of the Georgian era, for instance, has great advantages over the Tudor Gothic, and that the cathedrals of Milan, Burgos, and Leon require a different method of illumination than those of St. Paul's or St. Martin's-in-the Fields, &c., on the same grounds as architects in the south were not so lavish with windows, &c.

I will also abstain from laying too much weight on a point which Fergusson (quoted by Mr. J. B. Fulton) already has remarked, viz., the impression of the abnormal height in the cathedrals of Amiens, Beauvais, and Cologne, when seen in full light; nor need I mention those classical monsters which were imitated at a certain period even here in England at the cost of light and air.

Just as the Italian style tells us of the history of the Papacy in the Middle Ages of Thomas Aquinas, of the scholastic theology of the past, &c., and the English Gothic of Langton, De Montfort, Lewis, and Evesham, so the church in general speaks to us of the remnants of the culture of the past and of its first beginnings. And these beginnings, down to the age of Tertullian Christianity, banished lights from the church.

Lactantius ('Div. Inst.,' vi. 2) reproaches the heathens for the use of lights. It would be superfluous to quote Athanasius and Hierommus (and others) to strengthen evidence throughout the annals of the first three centuries. At last candles were admitted, but only and solely: "ad significandum lumine fidei illustratos sanctos decessisse et modo in superna patria lumine gloriæ splendere" (v., also adv., 'Vigil,' c. F). And only wax candles were allowed; those of fat were forbidden by the Congregatio Rituum. The odiferous wax was regarded as a product of the bee, which has to die after the accomplishment of her work. This was symbolism, but there is no beauty without symbolism, and no symbolism without beauty—and Divine service is beauty.

It would lead me too far to discuss the wonderful customs, myths, and superstitions which some congregations have retained to this very day. I will only recall the Candlemas Day of the Catholic Church (v. 'Posey of Prayers; or, The Key of Heaven,' 1799, p. 15), the old custom of the Festum Candelarum of the Romans, in honour of Flora, the mother of Mars, or of Proserpine, which Pope Sergius adopted, and which only remains to us as the last and real meaning of the light in the church. I will not allude to the allegory of the thirteen candles (Chirst and the Twelve Apostles), where the twelve candles are extinguished at *intervals* during successive parts of the service, until one only is left, which represents Christ deserted by the disciples, and

in the end that one is put out to signify his death (v. William Hone, 'Ancient Mysteries Described,' London, 1823).

All these examples only show us that light in the church had always a Spiritual or symbolical meaning. The light kindled in the Temple of Solomon was to testify that God was in the midst of Israel. Therefore in the Temple the windows were narrowed from without, to indicate that the light streams out from *within* (v. 'Tan. Tezawek,' ed. Baber, p. 4). But above all, people who promote the introduction of modern light in the churches totally forget the real object of religious houses—of places of *worship*. It must be cleared of modern deformities. The masses who pray to their God must wander in the gloom between pier and pillar, or sit in the twilight in order to speak to God as to one who knows and sees the secrets of the hearts as a child turns to its father or mother.

Now when modern light is introduced this fundamental fact of every worship is totally destroyed. The religious man enters a place of worship with the motto which stands since olden times on the entrance of temples and synagogues: "Enter the House of the Lord thy God with humility. Be attentive in time of prayer. Think upon the Creator." Mystical darkness and the solemn peals of the organ reverberating through the aisle and transepts of the church cannot fail in awakening the emotion of the least excitable beholder. Even an atheist, as Napoleon said in the cathedral of Amiens, "ne doit pas se sentir à son aise ici."

And were not often stained-glass windows introduced only and solely to increase solemnity by shedding a dim mysterious light, "a many-texted gloom," over the building?

We must retain the religious awe, the mysterious dark infinity.

The Jewish women of old lifted up both hands towards the Sabbath lights to guard their faces from the rays during prayer. Religious men ought also to lift their hands against metallic filament lamps, &c., in churches.

I am, yours faithfully,

Dr. B. Sch.

London, January 21st, 1909.

Incandescent Lighting in Belfast.

An example of the growing interest of local authorities in the details of street lighting seems to have been furnished by the Belfast County Borough Council. According to the *Journal of Gas Lighting* a sub-committee was appointed to patrol the City and see how well the streets were lighted.

This sub-committee returned to report that many of the burners and mantles in the district visited were out of order. However, the Chairman of the gas committee thought the mantles were not defective; instructions had been given that mantles were not to be thrown away when merely slightly broken at the end. Belfast was one of the best lighted cities in the Kingdom, and would compare favourably with Dublin.

Mr. Shaw and Dr. Williamson, however, seemed to think that more attention to renewal of mantles was necessary, and the latter remarked that though Belfast was well lighted, there was no reason why the lighting there should not be improved; the question to be considered was whether they were getting the best value from their mantles.

In any case it is interesting to observe indications of this kind of the growing appreciation of the fact that what is paid for in the streets is *light*.

A New Development in Petrol-Air Lighting.

We notice in a recent number of the *Gas World* a reference to what seems a somewhat novel development in petrol-air gas lighting.

Hitherto those advocating the merits of this system of lighting have usually insisted upon its value in cases in which no supply of gas or electricity is available—in remote country districts for example. It appears, however, that in Romford a number of adjacently situated shopkeepers propose to co-operate and erect a common air-gas generator, anticipating that the result will be cheaper than the local gas supply. It will be interesting to observe the development of this scheme.

Review of the Technical Press.

ILLUMINATION.

As usual there have been a fair number of editorials in different journals dealing with aspects of illumination. Thus *The Electrical World*, commenting upon the first meeting of the Association of Car-Lighting Engineers, remarks on the field that undoubtedly exists in the direction of IMPROVED CAR ILLUMINATION. At present the lighting is often inadequate, being too weak in many cases; in others the lamps are so placed as to shine straight into the passengers' eyes and at very close quarters. This last contingency requires a little scheming to avoid, but, as the journal truly remarks, this is an instance in which good shading is extremely essential.

Another editorial in the same journal discusses the DETERMINATION OF M. SPH. C.P. by graphic systems, expressing appreciation of a method involving the use of a specially constructed slide-rule, due to **Weinbeer,** and recently described in our columns (vol. i. p. 559). Yet another article in the same journal on "THE ECONOMICS OF LIGHTING" makes some very pertinent suggestions regarding the reasons why lighting arrangements are so often deficient. This arises from the fact that it is not unusually an afterthought pure and simple. The householder arranges his scheme of decoration, &c., and simultaneously approaches the limit of expenditure, and only then thinks of his lighting, with the natural result that money is now grudged.

L'Ellettricita reviews the question of the EFFECT OF ULTRAVIOLET RAYS on the eye that has recently been the subject of so much discussion at the hands of Schanz and Stockhausen, Voege, and others. Attention is drawn to the value of diffusing glass shades of the Holophane variety, which, besides diffusing the light in a proper manner, have the incidental advantage of effectually reducing the surplus ultra-violet radiation. It will be observed that another Italian periodical—*l'Ellettricista*—also deals with the questions of diffusing shades, containing a very comprehensive article on the action of the Holophane glass.

In the subject of STREET LIGHTING it may be noted that **Dr. Bloch's** contribution describing the RECENT PROGRESS IN BERLIN in this department, to which we have referred previously in this journal, is reproduced in *The Electrician* (Jan. 1 and 8). **Dr. Drehschmidt,** has now contributed a reply to the article in question in which, while admitting the strides electric lighting has made, he thinks that Dr. Bloch has not done justice to the recent developments in incandescent gas lighting. For instance, he draws attention to the apparent lack of uniformity in the results obtained from different flame arc-lamps, and states further that very recent improvements in the gaslights used in Berlin enable only 0·48 to 0·5 instead of 0·65 litres of gas to be expended per M. Hem. Sph. C.P.

Some discussion has recently been taking place on the subject of the relative merits of DIRECT AND INVERTED SYSTEMS OF LIGHTING. A recent paper by **S. D. Curtis** and **A. J. Morgan** before the Illuminating Engineering Society deals with fixtures of the latter type utilizing inverted tungsten lamps. A lecture of **Dr. C. P. Steinmetz,** before the same society, also discussed the value of shadowless and other systems of lighting, pointing out that in general we require more or less shadow; the question is also the subject of comment in *The Illuminating Engineer* (New York), and it may be asserted that the physiological phenomena underlying the matter are very far from being thoroughly understood as yet. There even seems to be some doubt expressed as to whether the eye, in travelling from a brightly illuminated surface to one of darker hue, is rested or wearied as a result, some asserting that the uniform illumination obtained from indirect systems is bad, because it does not provide the necessary opportunity for rest.

The article by **Prof. L. Weber** on the subject of the best UNIT OF INTENSITY OF ILLUMINATION has called forth a letter from **Dr. B. Monasch** justifying his suggestion that the "LUX" is the preferable term to use, and also his assertion that Cohn's figures were founded on the old German Vereinskerze, and therefore need revision. In reply Prof. Weber explains how the misunderstanding as to the latter point has arisen.

Among other articles mention must be made of the exceedingly valuable and complete article by **P. G. Nutting** on the "LUMINOUS EQUIVALENT OF RADIATION," in which he seeks to define the physiological basis of light perception in precise terms (*Bull. Bureau of Standards*, Nov., 1908). **Scheible** (*Elec. World*, Jan. 2) discusses the merits of lamppost

units in the street as opposed to a method that is becoming common in the United States of illuminating streets by hanging festoons of high candle-power tungsten lamps across them. **Vogel** contributes an interesting discussion of the REGION OF THE SPECTRUM that is valuable for different PHYSIOLOGICAL PURPOSES, and how these forms of radiation can best be obtained from the available artificial illuminants.

Weinbeer (*Z. f. B.*, Jan. 10 and 20) works out some forms of REFLECTORS FOR PROVIDING UNIFORM ILLUMINATION and makes an interesting comparison of the costs of various illuminants. *The Illuminating Engineer* of New York for December contains some striking accounts of the methods of INTERNAL DECORATION BY MEANS OF LIGHT employed in some of the NEW YORK RESTAURANTS.

ELECTRIC LIGHTING.

Among the articles and papers of the past month dealing with electric lighting mention may first be made of the communication of **Dr. Louis Bell** to *The Times Engineering Supplement,* dealing with the progress of the METALLIC FILAMENT LAMP IN THE UNITED STATES. There are several respects in which the conditions of the lighting industry in that country differ from those over here. For instance, Dr. Bell mentions that the control of lamp making is in the hands of a few big companies, who are thus enabled to co-operate upon a single line of policy. In the United States, also, it is usual for electrical supply companies to undertake the sale or free renewal of lamps to their consumers, and this co-operation has certain advantages. With both lamp companies and electricity supply companies co-operating to assist the consumer to realize the benefits of the new lamps their progress has been rapid; a recently issued report of the work of the Illuminating Engineering Bureau of the Boston Edison Electric Illuminating Co., established under Dr. Bell's supervision to advise their consumers, should be read with exceptional interest.

Coblentz (*Elec. World*, N.Y., Dec. 19) contributes an interesting note on the physical EXPLANATION OF THE HIGH EFFICIENCY OF METALLIC FILAMENT LAMPS. This, he explains, is now definitely believed not to be due to their high temperature of incandescence alone. Other matters of consequence are the value of the "radiation-constant" of such filaments which differs from that of a black body, and the peculiar low emissivity of metals in the infra-red regions in virtue of which less energy is wasted in the radiation of energy of this character.

Another interesting communication on the subject of incandescent lamp filaments is that of **Ritterburg** and **Hermann** in the *Zeitschrift für Beleuchtungswesen* for Dec. 30 of last year. The article contains an account of some experiments on the construction of high efficiency CARBON FILAMENTS of finely divided and homogeneous carbon, obtained by the suitable treatment of LAMP BLACK, and from the material forming the basis of CHINESE INK. In this case good results—a life of 1,000 hours at a consumption of 1 watt per H.K.—are said to have been obtained from the filaments so far tested.

Some newly published tests of tungsten METALLIC FILAMENT LAMPS FOR 220 VOLTS (*Z. f. B.*, Jan. 20) are also worthy of note; it is interesting to observe how many different firms now manufacture such lamps. The specific consumption of the different makes, however, seems in this instance to have varied considerably, ranging from 0·8 to 1·6 watts per H.K.

Among other items relating to incandescent electric lighting, reference may be made to the serial contribution of B. **Duschnitz**, and some particulars in the *Zeitschrift für Beleuchtungswesen* of recent patents on the subject of adjustable glow-lamps having several filaments in the same bulb, in order to enable several intensities to be obtained from the same unit.

As regards arc-lighting, prominence must be given to a long article by **J. Teichmüller** describing a number of experiments on the REGULATION OF FLAME-LAMPS. The author rightly points out that the problem differs very considerably from that of arc-lamps with ordinary "pure" carbons, the presence of a core and the liability to lack homogenity in the carbons being points of considerable importance. One novel conclusion arrived at is that the prevalent theory respecting the blow-magnet repelling the arc away, and so spreading it out, is not correct, and the author prefers a different explanation.

Some particulars of recent improvements in the Magnetite arc (*Z. f. B.*, Jan. 10) may also be noted.

GAS, OIL, AND ACETYLENE LIGHTING.

Mention has already been made of the contribution of **Prof. Drehschmidt** dealing with the IMPROVED GAS LIGHTING OF BERLIN (see under Illumination).

A. Cressy Morrison delivered an inspiring address to the Illuminating Engineering Society in Chicago. There were many points of wide general interest to the illuminating engineer, of whose value to the community Mr. Morrison enter-

tained no doubt; he referred particularly to the friendly attitude of the gas profession to the Illuminating Engineering Society. The speaker's views of the future of the gas industry were encouraging.

Some account has been given in several quarters of the results of adopting automatic methods of street lamp lighting and extinguishing. Thus **Dobert** (*J.f.G.*, Dec. 24, 1908) describes some experiences of the BAMAG DISTANCE-LIGHTING SYSTEM, and a recent number of *The Journal of Gas Lighting* contains a report of the automatic lighting of Liverpool.

Klatte (*J.f.G.*, Dec. 20) again returns to the charge with an article dwelling upon the merits of HIGH-PRESSURE AIR, as compared with high-pressure gas, for incandescent gas lights, and gives the experiences of the Pharos Company who make both varieties of lamps, and should therefore be able to view the merits of the respective systems impartially.

E. F. Willson recently read a paper on the LIGHTING OF STREETS IN SMALL URBAN DISTRICTS, and described the conditions of the plant under his charge. An interesting discussion followed, some difference of opinion being expressed on the subject of mantle-repair. Mr. Willson stated that this worked out 5½ per lamp per annum only. Another speaker, however, thought that this was exceptionally low, for, after a heavy gale, as many as 75 per cent of the mantles might need replacing. He also stated that he had never been able to get more than about 35 candle-power from a mantle consuming 3.5 cubic feet per hour under ordinary conditions though 70 candle-power was claimed, and might be possible if certain conditions as regards the pressure and gas supply were complied with.

The question of replacing mantles is also touched upon in an article on the GAS LIGHTING OF TRAINS in the Isle of Wight, and elsewhere. In a test of 23 days, 4 out of 19 mantles on a single coach were renewed. The gas is stored at a pressure of 150 lb. per square inch, and in the burners 25 candles for 1.63 cubic feet of gas are obtained. It is stated that the results are cheaper than by oil-gas, and that the use of the latter system is now no longer essential in such cases.

Recent numbers of the *Revue des Eclairages* and *Acetylene* contain a number of articles dwelling on certain points connected with acetylene lighting; among these mention may be made of that on the FOULING OF BURNERS, which was at one time a great source of trouble. This may arise through chemical, mechanical, and physical effects, one of the most common being the tendency of impure acetylene to form inconvenient polymerides; the presence of phosphoretted hydrogen in the gas is specially liable to produce obnoxious compounds of this nature.

A few communications on the subject of PETROL-AIR GAS have also appeared, including a letter from **W. Key** in *The Journal of Gas Lighting*. The writer describes his experiences in arranging to light a small village by a petrol-air gas plant. It is interesting to note that he considers 2 per cent petrol-air unsatisfactory, and would not recommend anything less than 10 per cent for ordinary lighting.

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Reflections on Lamps (*Elec. Rev.*, Jan. 8).

ELECTRIC LIGHTING.

Bell, Dr. L. The Metallic Filament Lamp in the United States (*Times Engineering Supplement*, Jan. 6).
Coblentz, W. N. The Luminous Efficiency of Metallic Filament Lamps (*Elec. World*, N.Y., Dec. 19, 1908).
Duschnitz, B. Metallische Leuchtfäden und Metallfadenlampen in der Fabrikation und in der Praxis (*Elek. Anz.*, Dec. 20).
Findlay, J. Incandescent Lamps (*Electrician*, Dec. 25).
Phelps, J. W. Glühlampe mit mehreren Fäden (*Z. f. B.*, Dec. 30).
Macpherson, H. H. Sidelights on Central Station "New Business Work" (*Elec. World*, N.Y., Dec. 19).
Neale, R. E. A Series of Comparisons between Electricity and Gas (*Elec. Mag.*, Jan., *continued*).
Ritterburg and Hermann. Fäden für elektrische Glühlampen aus Russ und Chinesischen Tusche (*Z. f. B.*, Dec. 30).
Teichmüller, J. Uber das Regulieren der Bogenlampen mit schrägen Kohlen und Blasmagneten (*E. T. Z.*, Dec. 17, 24; *J. f. G.*, Dec. 24; *Elec. Engineering*, Jan. 7).
The Tungsten Lamp Situation (*Elec. World*, N.Y., Jan. 2).
Developments in the "I-Comfort System" (*Elec. Review*, N.Y., Jan. 2).
Metallfadenlampen für 220 volt (*Z. f. B.*, Jan. 10).
Neuere Verbesserungen der Magnetitbogenlampe (*Z. f. B.*, Jan. 10).
The Wiring of Finished Residences (*Elec. World*, N.Y., Dec. 19).
Wiring a Finished Building without Defacement (*Elec. World*, Jan. 7).

GAS, OIL, AND ACETYLENE LIGHTING.

Anzbock, J. Comparisons entre la lumière électrique et la lumière du Gaz (*Rev. des Eclairages*, Dec. 15, 1908).
Cressy Morrison, A. The Progress of the Gas Industry (*Am. Gaslight Jour.*, Jan. 4).
Dobert, H. Erfahrungen mit Laternen- Fernzündungsapparaten (*J. f. G.*, Dec. 24).
Drehschmidt, H. Die neuesten Fortschritte der Berliner Strassenbeleuchtung in Vergleich mit den bisherigen Beleuchtungsarten (*J. f. G.*, Jan. 16).
Editorials. L'Etat actuel et l'avenir des différents modes d'Eclairage (*Rev. des Eclairages*, Jan. 15).
The Correct Measurement of Gas (*G. W.*, Dec. 26, 1908).
The Price and Quality of London Gas (*G. W.*, Jan. 9).
Dr. L. Bell on Metallic Filament Lamps (*G. W.*, Jan. 9).
Automatic Street Lighting in Liverpool (*J. G. L.*, Jan. 12).
Graham, M. Round the World and some Gasworks (*J. G. L.*, Jan. 5, Jan. 19).
Guilleaume, J. Ce qui coute l'Eclairage (*Rev. des Eclairages*, Jan. 15).
Key, W. Petrol-Air Gas (Correspondence, *J. G. L.*, Jan. 12).
Klatte, O. Intensiv-Gasbeleuchtung mit Pressgas und mit Pressluft (*J. f. G.*, Dec. 20, 1908).
Owens, H. T. Entrance Lamps in New York City (*Prog. Age*, Jan. 1).
Maur, J. D. von. High Pressure Distribution in St. Louis (*G. W.*, Jan. 2).
Protais, L. Buisson-Hella et Acetylene (*Rev. des Eclairages*, Jan. 15).
Schimming, G. Die Technische Entwicklung der Berliner städtischen Gaswerke in den letzten zehn Jahren (*J. f. G.*, Jan. 9).
Walker, S. F. The Life of Incandescent Lamps (*G. W.*, Jan. 9, Correspondence).
Willson, E. F. Street Lighting in small Urban Districts (*J. G. L.*, Jan. 12).
Town Gas for Railway-Carriage Lighting (*J. G. L.*, Dec. 29, 1908).
The Lighting of Fleet Street (*G. W.*, Jan. 2).
Verfaheren zum Zeichnen von Glühstrumpfen......Glühlichtbrenner fur flussige Brennstoffe (*Z. f. B.*, Jan 20).
Inverted Gas Lighting or Metallic Electric Lamps for Street Lighting (*J. G. L.*, Jan. 12).
Portable Acetylene Lamps in Mines (*Acetylene*, January).
The Fouling of Acetylene Burners (*Acetylene*, Dec., 1908).

MISCELLANEOUS.

Coblentz, W. Selective Radiation on the Part of Various Solids (Bull. Bureau of Standards, Nov., 1908).
Nichols, E. L., and Merrit, E. Studies in Luminescence (*Phys. Rev.*, Nov., 1908).

CONTRACTIONS USED.

E. T. Z.—*Elektrotechnische Zeitschrift.*
Elek. Anz.—*Elektrotechnischer Anzeiger.*
G. W.—*Gas World.*
Illum. Eng., N.Y.—*Illuminating Engineer of New York.*
J. G. L.—*Journal of Gaslighting.*
J. f. G.—*Journal für Gasbeleuchtung und Wasserversorgung.*
Prog. Age.—*Progressive Age.*
Phys. Rev.—*Physical Review.*
T. I. E. S.—Transactions of the Illuminating Engineering Society.
Z. f. B.—*Zeitschrift für Beleuchtungswesen.*

PATENT LIST.

COMPLETE SPECIFICATIONS ACCEPTED OR OPEN TO PUBLIC INSPECTION.

I.—ELECTRIC LIGHTING.

28,138/07. Electric lamps (C.S.) I.C. Dec. 27, 1906, Germany. Accepted Dec. 23, 1908. Allgemeine Elektricitäts-Ges., 83, Cannon Street, London.

104. Lamp fitting. Jan. 2, 1908. Accepted Dec. 31, 1908. C. M. Escaré, P. F. Escaré, and C. Damev, 9, Osborne Road, Thornton Heath, Surrey.

4,066. Series-parallel lighting circuits. Feb. 22, 1908. Accepted Jan. 13, 1909. W. H. Exley and H. Leitner, 4, South Street, Finsbury.

4,956. Incandescent bodies for lamps (C.S.). March 4, 1908. Accepted Dec. 23, 1908. F. G. Planchon, 40, Chancery Lane, London.

5,040. Metallic filaments for incandescent lamps (C.S.). I.C. Nov. 9, 1907, France. Accepted Jan. 20, 1909. F. J. Planchon, 40, Chancery Lane, London.

5,829. Arc lamps. March 16, 1908. Accepted Jan. 20, 1909. A. D. Jones, Hartham Works, Hartham Road, Holloway.

7,674. Attaching shades and reflectors to incandescent lamps. April 7, 1908. Accepted Jan. 13, 1909. C. W. Dawson, 30, Park Row, Leeds.

10,341. Incandescent lamps. May 12, 1908. Accepted Jan. 13, 1909. The British Thomson-Houston Co., Ltd., 83, Cannon Street, London. (From Allgemeine Elektricitäts-Ges., Germany.)

11,460. Incandescent lamps. May 26, 1908. Accepted Jan. 20, 1909. The British Thomson-Houston Co., Ltd., and T. E. Robertson, 83, Cannon Street, London.

14,080. Switch holders for incandescent lamps (C.S.). July 2, 1908. Accepted Dec. 31, 1908. M. Roth, 111, Hatton Garden, London.

16,797. Arc lamps (C.S.). Aug. 10, 1908. Accepted Dec. 23, 1908. T. J. Rensing, 24, Southampton Buildings, London.

17,535. Arc lamps (C.S.). I.C. Aug. 21, 1907, Germany. Accepted Dec. 23, 1908. Allgemeine Elektricitäts-Ges., 83, Canon Street, London.

17,618. Refractory conductors (C.S.). I.C. Aug. 24, 1907, U.S.A. Accepted Jan. 13, 1909. W. C. Arsem, 83, Cannon Street, London.

18,233. Incandescent lamps (C.S.). I.C. Jan. 10, 1908, France. G. Weissmann, 20, High Holborn, London.

21,332. Holders for incandescent lamps (C.S.). October 9, 1908. Accepted Dec. 31, 1908. C. M. Dorman, R. A. Smith, and H. G. Baggs, Ordsal Electrical Works, Salford, Manchester.

27,144. Production of pure and thin filaments of any length (C.S.). I.C. Dec. 13, 1907, Germany. A. Kroll and B. Saklatwalla, 322, High Holborn, London.

28,554. Production of flat metallic filaments (C.S.). I.C. Jan. 2, 1908, Germany. W. Shäffer, 111, Hatton Garden, London.

II.—GAS LIGHTING.

28,360. Gas lamps. Dec. 24, 1907. Accepted Dec. 31, 1908. J. Keith and G. Keith, 65, Chancery Lane, London. (Cognate applications, 1994/08 and 7544/08).

1,994. *See* 28,360/07, *above*.

2,607. Incandescent street lamps. Feb. 5, 1908. Accepted Dec. 31, 1908. T. Glover, 173, Fleet Street, London.

2,608. High-pressure incandescent burners. Feb. 5, 1908. Accepted Dec. 31, 1908. W. Glover, 173, Fleet Street, London.

7,220. Inverted incandescent fittings. April 1, 1908. Accepted Jan. 20, 1909. J. Webber, 18, Southampton Buildings, London.

7,544. *See* 28, 360/07, *above*.

8,690. Controlling gas cocks by variation of pressure in mains. April 21, 1908. Accepted Jan. 20, 1909. E. Sparks, 24, Hugo Road, Tufnell Park, London.

10,715. Automatic igniters and extinguishers (C.S.). May 16, 1908. Accepted Dec. 23, 1908. Mr. W. Bröndum, 345, St. John Street, London.

13,693. Incandescent burners and anti-vibrating devices therefor (C.S.) June 29, 1908. Accepted Jan. 13, 1909. T. Eaves, 4, St. Ann's Square, Manchester.

16,074. Inverted incandescent burners. July 29, 1908. Accepted Dec. 23, 1908. J. Dittrich, 15, Ampton Street, Gray's Inn Road, London.

16,278. Lamps (C.S.). July 31, 1908. Accepted Jan. 13, 1909. W. E. Lake, 7, Southampton Buildings, London (From Aurora Illuminating and Mantle Co., U.S.A.).

19,013. Automatic gas cut-off devices (C.S.). Sept 10, 1908. Accepted Dec. 31, 1908. H. Niemann, 51, Deansgate Arcade, Manchester.

III.—MISCELLANEOUS

1,113. Burners for acetylene flare lamps. Jan. 17, 1908. Accepted Dec. 23, 1908. W. Harris and F. R. Stone, Lloyd's Bank Buildings, Bristol.

3,087. Incandescent petroleum lamps. Feb. 11, 1908. Accepted Jan. 13, 1909. M. Malkiel, 6, Lord Street, Liverpool.

3,170. Incandescent lamps. Feb. 12, 1908. Accepted Dec. 31, 1908. A. Krzywiec, 6, Lord Street, Liverpool.

3,899. Incandescent gas and oil lamps. Feb. 21, 1908. Accepted Dec. 23, 1908. J. Royle and J. Darbyshire, 139, Dale Street, Liverpool.
6,971. Photometer. March 30, 1908. Accepted Jan. 20, 1909. W. Fennell and W. P. Perry, 68, Dudley Road, Tipton, Staff.
7,740. Globe galleries (for gas and electric light). April 7, 1908. Accepted Dec. 23, 1908. S. Mundler, 4, South Street, Finsbury.
18,508. Illuminating interiors (C.S.). Sept. 3, 1908. Accepted Dec. 23, 1908. F. Luithlen, 65, Chancery Lane, London.
20,076. Acetylene and like burners (C.S.) Sept. 24, 1908. Accepted Dec. 31, 1908. A Bray, Sunbridge Chambers, Bradford, Yorks.
28,435. Incandescent filaments (gas and electric). (C.S.). I. C., Jan. 10, 1908, Switzerland. R. Laigle, 18, Southampton Buildings, London.

EXPLANATORY NOTES.

(C.S.) Application accompanied by a Complete Specification.
(I.C.) Date applied for under the International Convention, being the date of application in the country mentioned.
(D.A.) Divided application: date applied for under Rule 13.
Accepted.—Date of advertisement of acceptance.
In the case of inventions communicated from abroad, the name of the communicator is given after that of the applicant.
Printed copies of accepted Specifications may be obtained at the Patent Office, price 8*d.*
Specifications filed under the International Convention may be inspected at the Patent Office at the expiration of twelve months from the date applied for, whether accepted or not, on payment of the prescribed fee of 1s.
N.B.—The titles are abbreviated. This list is not exhaustive, but comprises those Patents which appear to be most closely connected with illumination.

Publications Received.

Die Wahrnehmung des Lichtes und der Farben, by Dr. F. W. Edridge Green, F.R.C.S. (Berliner, klin. Wochenschr, 1909, No. 1.)—An account of some experiments and theories on the subject of the perception of light and colour, and the parts played by the retinal organs; to this paper we mean to refer in detail subsequently.

Ueber die Wirkung der ultraviolletten Strahlen auf das Auge, by Dr. F. Schanz and Dr. K. Stockhausen. (Graefe's Archiv. LXIX. 3.)—A description of some further and more extensive experiments on the subject of the effect of ultra-violet light on the eyes, following those previously described in this journal.

Also *Prospectus of the Recent Gas Appliance Exhibition, Dec.* 7–12, 1908, *held in Chicago, U.S.A.—List of Publications of the Verband Deutscher Elektrotechniker.*

TRADE NOTES, &c.

We have received a series of publications describing the *Cox Air Gas System*, utilizing 1·4 per cent of petrol vapour to 98·6 per cent of air, the mixture being produced by the operation of a small hot-air engine. Among the advantages of the method are claimed extreme cheapness, perfect safety, and the absence of products of combustion liable to discolour ceilings, decorations, &c.

From *Messrs. Pilkington Bros.* (St. Helens, Lancashire) we receive specimens and particulars of the rolled prismatic glass manufactured by this firm used in windows, &c., with the object of increasing the daylight available, and distributing it to the best advantage. We are also indebted to the *Maximum Light Co.* (Victoria Street, S.W.) for likewise sending particulars and specimens of specially designed glass to serve this purpose, being grooved at suitable angles on one side, and provided with lens-action on the other.

We are informed that, in addition to the Grand Diploma of Honour conferred upon the *Kitson-Empire Lighting Co., Ltd.*, for their exhibit at the Franco-British Exhibition, a Medal of Merit has been awarded to Mr. Arthur Kitson, the inventor of the system and founder of these businesses.

Among other pamphlets and publications received we beg to acknowledge the receipt of '*Installation News*,' published by *Simplex Conduits, Ltd.*, for November; also '*On Lighting*,' an illustrated leaflet describing the application of *Mansfield's Oil-Gas* for lighting, cooking, and power generally.

We have also received a description of the *North-Western Patent Lamp-Lowering Gear* (Cathcart, Glasgow), by which, it is claimed, the use of tower-ladders, &c., to enable trimmers to operate arc lamps in the street is avoided, a satisfactory and electrical contact, together with good quality of insulation, being guaranteed. The arrangements have been in use for five years, and are stated to be reliable even in the most exposed conditions.

Also a description of the "*Niphan*" plugs and flexible conductors for use with electric cables, a description of the *Bamag* distance gas lighter, and a pamphlet containing particulars of *Messrs. Elliot Bros.*' alternating current instruments.

The
ELECTRICITY · ACETYLENE · OIL · GAS
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Edited by
LEON GASTER

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EDITORIAL.

Formation of the Illuminating Engineering Society.

As readers will gather from the account of the proceedings elsewhere, it was decided at an informal dinner, held at the Criterion Restaurant on February 9th, to inaugurate an Illuminating Engineering Society in this country.

Invitations to this dinner were issued by the Editor, in his private capacity, and the dinner was in this respect an informal one, though the extremely representative character of those present rendered it of great historic interest. In this connexion the Editor would like to explain at once that, in selecting representatives of all the different professions interested, it was naturally not possible for him to invite many whose genuine enthusiasm would have rendered them extremely welcome. He hopes, therefore, that any omission will not be misconstrued and that, when the Society is formally called together, very shortly, he will have the pleasure of then seeing all those who are interested in the subject.

It may also be explained that no representatives of the technical press were invited on this occasion, partly because of the semi-private character of the proceedings, and also because it was felt that, while it was impossible to issue a general invitation, it would, on the other hand, have been open to misconstruction to invite only representatives of those journals who had shown themselves particularly friendly to the movement.

The proceedings at this dinner are described elsewhere. It will be seen

that the important decision was arrived at that the *Illuminating Engineer* should be appointed the official organ of this Society. We think that this removes what most people must have felt to be a great difficulty in the case of a new Society, namely, the publication of their proceedings at reasonable expense. On the other hand the standing and the impartial attitude of the *Illuminating Engineer* have rendered it peculiarly fitted to undertake this work. As a result of this decision there need be no difficulty in starting the Society with quite a limited number of members at a small annual subscription.

An account of our views regarding the nature of the proposed Society are fully dealt with in the speeches at this dinner, and it is unnecessary to do more than insist on one very important point here. We wish to emphasize once more the fact that what is proposed is *not* a Society of Illuminating Engineers, but an "Illuminating Engineering Society." In other words, we only desire an impartial platform on which all these questions can be discussed in a friendly spirit; anyone interested in them may become a member, but, on the other hand, membership of the Society will not confer any professional status.

The Cantor Lectures on Illumination.

The present opportunity should not be allowed to pass without a few remarks on the magnificent work that has been done already by the Royal Society of Arts, in connexion with matters relating to illumination. Although the writer believes himself to be not behindhand in knowledge of the Society's doings, it was recently a revelation to discover how much in this respect has been done in the past. Over a hundred papers dealing with different aspects of lighting and illumination have been published. Opportunities for the discussion of all methods of lighting, from the candle to the newest electric lamps, have been afforded, and many years ago the Royal Society of Arts had already offered prizes for the invention of miner's lamps, lighthouse apparatus, and other practical developments of illumination. It is, indeed, characteristic of the Society that they have invariably been interested not only in the latest developments, but in their practical utilization, and it is therefore only meet that they should encourage, not only the science of light-production, but also the kindred "science and art of illuminating engineering."

One other illustration of their connexion with the subject in which we are interested is the attention that has been paid by several lecturers before the Society, notably Dr. Brudenell Carter, to the important question of eyesight. Since the date of these lectures we have seen an awakening of public opinion as to the importance of this question; we now observe with interest a similar awakening as to its connexion with good conditions of illumination.

It was, therefore, only to be expected that the Society of Arts, recognizing the immense strides that have recently taken place in the devolopment of all methods of lighting, and particularly the spread of the movement now termed "Illuminating Engineering," should decide to devote a series of Cantor lectures during the present year to this subject.

During the past month the Editor has had the privilege of delivering two of these lectures on 'Modern Methods of Illumination'; these were delivered on February 15th and 22nd respectively, and dealt with gas and electric lighting.

The attempt to deal with a subject so vast leads one to assume a humble attitude of mind. Naturally, it is impossible to do more than make very brief mention of a few salient points in each subject in a lecture of one hour's

duration, and to call attention to the development in the point of view from which these matters are now regarded by engineers.

It is extremely gratifying to find such a distinguished Society as the Royal Society of Arts selecting illumination as the subject for the famous Cantor lectures, and is pleasing as a striking recognition not only of the standing of this journal, but also of the genuine public interest that it has helped to arouse in the subject. It was also encouraging to observe the keen interest with which the details of the representative collection of different systems of illumination were followed by those present, and the Editor wishes to take this opportunity of very cordially thanking all those who rendered such valuable assistance by exhibiting and explaining the methods of lighting with which they were connected.

At the same time the Editor hopes that these friends will realize how, in a lecture of an hour's duration, it is, naturally, impossible for a lecturer to deal with any particular exhibit in any detail; if, therefore, he has accidentally omitted to make adequate reference in the course of his remarks to any exhibit, he hopes the reason for this will be understood, and he will endeavour to make the published account more complete. Meantime, by the kind permission of the Royal Society of Arts, an abbreviated account of these lectures will follow in the coming numbers of *The Illuminating Engineer*. The first lecture on electric lighting is dealt with in the present issue. The complete lectures will be published in the Journal of the Society during the summer.

The Carbon and the Metallic Filament Lamp.

In the general excitement following the commercial introduction of metallic filaments there is a little danger, as we have pointed out previously on several occasions, that their field of application may not be studied with the needful discernment, and that disappointment may follow the indiscriminate pushing of these lamps in all directions, without inquiring into the exact circumstances of each case under consideration. We have spoken previously of the province of the illuminating engineer in selecting the illuminants best fitted to comply with any particular requirements, but it may truly be said that there would be a welcome field for his efforts in discriminating between the conditions favouring the use of metallic and carbon filament lamps alone.

Naturally much depends upon the pressure and nature of the supply, and the local cost of electrical energy, &c. But a further possibility affecting this choice, touched upon in the series of tests described in a communicated article in the present number, lies in deliberately over-running carbon lamps in order to produce a condition of things intermediate between those characteristic of the metallic and the carbon filament, as usually employed. Now that the price of carbon lamps of good quality is becoming relatively low, in comparison with that of metallic ones, it may well be worth while in special cases to sacrifice their life to some extent by over-running them at higher than their normal voltage, thus considerably increasing their efficiency, especially in cases in which a comparatively high voltage makes it difficult to utilize metallic filament lamps of low candle-power, in order to gain the advantage of saving current.

There are also frequently situations in which a good local light is wanted, but only very occasionally; under these conditions an over-run lamp of good quality may last quite as long as need be at a high efficiency, and its comparatively restricted use may not justify the heavy initial expense of a metallic lamp. Again, in circumstances in which economy must be studied and the efficiency of the metallic filament is very desirable, but rough usage and vibration renders their installation hazardous, the plan of over-

running carbon lamps may be at least worth a trial.

The Art of Shading.

The article by Mr. J. Darch on this subject in the present and our last number deals with a matter which goes to the very root of successful illuminating engineering.

In the past comparisons between different systems of illumination have been almost invariably based upon questions of cost. As a matter of fact, however, except in a limited number of cases, comfort, and artistic appearance are equally vital considerations, and it is impossible to secure either without taking considerable pains to utilize our light under the best physiological conditions.

It may, in fact, now be accepted as a principle that the source of light itself is an incomplete unit, until it has added to it a suitable diffusing shade. Mr. Darch in his article insists upon an intrinsic brilliancy of not more than 0·05 candle-power per square inch—a figure which is considerably lower than at one time considered satisfactory, but resembles that quoted by Mr. Woodwell at the second Annual Convention of the Illuminating Engineering Society last year (*Illuminating Engineer*, Vol. 1., 1908, page 1005).

As far as the artistic and physiological factors are concerned, the old silk shade still holds its own, and some of the devices described by Mr. Darch are of a kindred character, that is to say, they are used purely and simply for the purpose of shading as apart from distribution.

Naturally, under these conditions it may be possible to secure a very pleasing result coupled with sufficient illumination for utilitarian purposes, but we inevitably lose a great deal of light in doing so. In the eyes of the illuminating engineer, a shade is usually intended not only to shield our eyes, but also to distribute the light to the best advantage, and to concentrate it in the directions in which we want it to fall. It is for this reason that the scientific Holophane glassware is so effective. Many people, however, are loth to lose the pleasing appearance of illuminated silk shades, and the illuminating engineer is called upon to secure the efficient results from scientific glassware, coupled with the artistic appearance. This often calls for a little ingenuity.

Fortunately, shades are generally installed upon sources intended to throw their light immediately downwards. There is, therefore, no difficulty in using a concentrating Holophane reflector with a suitable silk shade hung over it. The reflector throws the light down in an efficient manner, and yet allows sufficient light to penetrate upwards to light up the silk satisfactorily.

The value of such surfaces, illuminated by transmitted light, for purely decorative purposes is, indeed, a point which illuminating engineers would do well to bear in mind. Certainly it presents in itself an interesting field for study, for there seems room for further data as to the exact order of illumination necessary to render them interesting to the eye, quite apart from the advisability of avoiding a brightness that is actually injurious.

The main point of interest in this article may be summed up by saying that we ought now to regard the source of light itself as the crude product merely until we have made arrangements for its effective shading and distribution. Especially is this true in cases in which the source is apt to fall within the direct line of vision.

LEON GASTER.

Review of Contents of this Issue.

Mr. A. P. Trotter (p. 151) concludes his description of VARIOUS TYPES OF PHOTOMETERS by an account of the LUMMER-BRODHUN instrument, special reference being made to the "Contrast" form, by the aid of which, it has been stated, a sensitiveness of one part in a thousand can be attained.

An abstract is given of the first of a series of Cantor Lectures before the Royal Society of Arts, that are being delivered by the Editor of this Journal, **Mr. Leon Gaster.**

This lecture, dealing with RECENT PROGRESS IN ELECTRIC LIGHTING, was delivered on February 15th. The subject proper of the lecture was prefaced by a short account of the development of illumination within recent years, special attention being drawn to the increase in printed matter, the spread of education, and other changes which, in common with developments in methods of lighting, lead us to use our eyes far more severely than in the past. The lecturer, therefore, recommended that the structure of the eye and the effect of light upon it should be studied with reference to the subject of illumination.

The recent developments in glow-lamps were then dealt with in a general manner, and such questions as the use of transformers, and the necessity for the standard specification for glow-lamps referred to. In this connexion the respects in which conditions in the United States differ from those in this country are pointed out, and approval expressed of the action of the Boston Edison Electric Illuminating Co. in establishing an illuminating engineering department for the benefit of consumers. Particulars are also given of the main lines of development of arc-lights, mercury-vapour lamps, and the Moore tube, and a few comments are made on the possibility of applying phosphorescent materials for the purposes of light production.

One of the most important events of the last month has been the decision to form an ILLUMINATING ENGINEERING SOCIETY in this country. This formed the subject of discussion at a dinner held at the Criterion Restaurant, London, W., on February 9th, which was attended by a very representative assembly of those connected with different aspects of illumination. Mr Gaster, at whose invitation these representatives were present, gave a brief account of the development of the illuminating engineering movement in this country, and those who spoke all expressed their warm approval of the aims of such a Society, and of the lines on which it was proposed that it should be constituted. It was decided that *The Illuminating Engineer*, published in London, should be appointed the official organ of the Society, and a provisional Committee was formed for the purpose of considering the statutes, &c., previous to an inaugural meeting to be held shortly. An account of the proceedings is given on p. 154.

Mr. J. Darch, F.S.I., completes his contribution dealing with THE ART OF SHADING. He considers the question from the physiological standpoint of shielding the eyes, and by the aid of a number of illustrations suggests methods by means of which the direct rays of different sources can be screened from the eyes of those seated in an ordinary room, engaged in ordinary occupations (p. 173).

The article by an Engineering Correspondent on the ECONOMICAL POSSIBILITIES OF LIGHTING BY CARBON FILAMENT LAMPS is completed in the present number (p. 177). The writer seeks to show that it would frequently be desirable for carbon filament lamps to be run at a higher efficiency than is customary, and that the exact efficiency at which the lamps in a district are used ought to depend on the local cost of electrical energy. He illustrates these contentions by a series of tests of 100 and 200-volt lamps.

Mr. J. B. Clarke (p. 181) describes the Bristol Public Lighting Curve, and gives some particulars of the lighting in this city. He makes some comparisons of the results of lighting according to the calendar, usually uncorrected for the latitude of the place under consideration, or by actual climatic conditions.

Mr. W. B. von Czudnochowski (p. 186) contributes a description of the exhibits dealing with illumination at the recent exhibition of shipbuilding in Berlin. He describes a number of methods of applying gas, liquid fuels, and electricity to lamps for use with searchlights and beacons, and gives some account of automatic devices for the purpose of producing intermittent "group-flashing." One interesting development is the control of isolated buoys by the use of a selenium cell, which, responding to the daylight, enables the buoy to be automatically lighted up and extinguished as the light waxes and wanes.

Mr. Lancelot Wild describes the use of Mirrors in Photometry (p. 193). Such mirrors are mainly used in apparatus for the purpose of obtaining the curves of distribution of sources which cannot themselves be easily moved. A special application of mirrors utilizing the Russell-Leonard system, described by the author, enables the mean spherical candle-power of a glow-lamp to be obtained by a single measurement.

Several other articles deal with the system of Inverted Lighting by Means of Tungsten Lamps (pp. 184 199). The first of these articles describes the lighting of Manchester Infirmary by this means; the second deals with a paper recently delivered by **A. D. Curtiss** and **A. J. Morgan** before The Illuminating Engineering Society in the United States. It is pointed out that this system may find more frequent application now that really efficient high candle-power glow-lamps are available: previously it had been utilized mainly in connexion with arc-lighting, which was not sufficiently steady for the illumination of residences.

Among other articles reference may be made to that dealing with the ventilation of photometer-rooms (p. 203), a question that has recently engaged the attention of the American Gas Institute. Some curves are given illustrating the manner in which the ratio between the intensities of two gaseous sources varies when the conditions of the atmosphere in the photometry room are altered.

A recent contribution by **Dr. F. W. Edridge Green** (p. 210) deals with the physiological basis of the Perception of Light and Colour.—This has been generally explained on the supposition that the minute light perceiving organs, the rods and the cones share these functions between them, and have distinct properties. Dr. Edridge Green, however, mentions several respects in which he finds the conventional explanation satisfactory, and is disposed to attach importance to the part played by the visual purple, rather than by these actual organs.

In the **Correspondence Columns** of the present number will be found a communication from **Dr. W. Voege**, dealing with the question of the Effect of Ultra-Violet Light on the Eyes, in which he replies to the criticism of Drs. Schanz and Stockhausen (*Illuminating Engineer*, vol. i. p. 1049). He explains that, while recognizing the existence of such an injurious effect, and the necessity for guarding against it when dealing with naked arc-lamps, &c., at close quarters, he does not consider the necessity proved for surrounding all modern illuminants by special absorbing shades intended to remove any trace of this constituent in their spectrum.

Another communication deals with the subject of Church Lighting. Two other letters from **Mr. C. Paterson** and an Engineering Correspondent deal with the Life-Tests of Glow-Lamps, published by the latter in his article on 'The Economical Possibilities of Lighting by Carbon Filament Glow-lamps' in preceding numbers of *The Illuminating Engineer*. At the end of this volume will be found the usual **Review of the Technical Press** and the **Patent List.**

TECHNICAL SECTION.

[*The Editor, while not soliciting contributions, is willing to consider the publication of original articles submitted to him, or letters intended for inclusion in the correspondence columns of 'The Illuminating Engineer.'*

The Editor does not necessarily identify himself with the opinions expressed by his contributors.]

Illumination, Its Distribution and Measurement.

By A. P. Trotter,

Electrical Adviser to the Board of Trade.

(*Continued from p.* 82.)

The Lummer-Brodhun.—The photometers which have been described in these articles are all of great simplicity, the optical arrangements are easy to understand, and the essential parts of them are easy to make. In an earlier article* it was stated that certain types of photometers, though at first sight appearing very different, and having no structural resemblance whatever, are indeed closely related. The difference between the complicated photometer now to be described and the Ritchie wedge is obvious enough; the relation between them will be explained later.

The instrument appears to have been first described† in 1889. The illustration Fig. 63 shows the essential parts. Light from lamps in the direction A and B falls on the two opposite sides of a screen S. This screen is made of some carefully prepared white material such as compressed magnesia or barium sulphate. Two mirrors or totally reflecting prisms are placed at M_1 and M_2. and a pair of prisms are placed at P_1 and P_2. These consist of an ordinary right-angled prism P_2 with a flat base, and a prism P_1 also right-angled, but having part of its base removed by sand-blasting or etching. The two bases are brought under pressure into optical contact. The whole arrangement is contained in a blackened box. Light from the direction A, falls on the screen S, and is reflected in the mirror M_1. Thence, some of it passes straight through those parts of the prisms P_1 and P_2 which are in optical contact, and through a microscope, to the observer in the directions O, while the rest, falling on

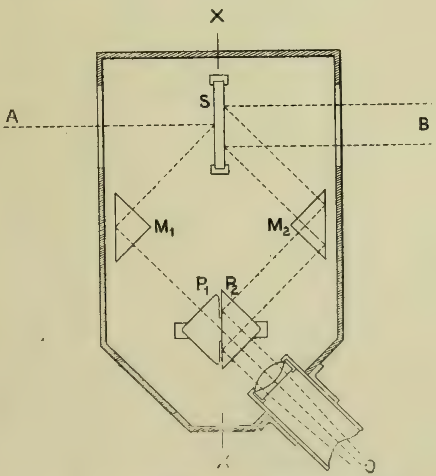


Fig. 63.—Lummer-Brodhun Photometer.

the sand-blasted portion of the base of prism P_1 which is not in optical contact is stopped.

The light from the direction B, shown, for clearness, by a double line, is reflected from the other face of the screen S, on to the mirror or prism M_2, and some of it passes straight through the prisms P_2 and P_1 and is lost, while

* Vol. I., p. 799.

† Zeitschrift für Instrumentenkunde, 1889, p. 41. *Lumière Electrique*, Vol. XXXIII., p. 410.

the rest falls on that part of the base of P_2 which is not in optical contact, and is totally reflected to the microscope.

If the surface of optical contact between the prisms is circular, the observer will see a sharply defined oval patch, being an oblique view of the circle, and through this, as through a window, he will see one side of the screen S, reflected in M_1. Surrounding this opening he will see, reflected from the base of P_2 and reflected again in M_2 the other side of the screen S. He will, in effect, see part of one side of the screen through a hole in the other side of it. This ingenious system of prisms seems first to have been employed for photometers by L. Weber in 1888, but that instrument was essentially an illumination photometer, and will therefore be described in a later section.

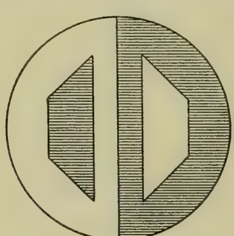


FIG. 64.—Lummer-Brodhun Photometer, Contrast Field out of Balance.

The instrument has been elaborated in several ways. Instead of a simple circular surface of optical contact between the prisms, the base of P_1 is etched so that a symmetrical pattern is produced. Fig. 64 shows such a pattern as seen when the photometer is out of balance. When a balance between two lights of a similar colour is effected, the field should be uniform all over, and the pattern should disappear. But the construction of the apparatus is so complicated, there are so many surfaces to keep clean, and such exact adjustment of the parts is necessary, that the whole of the field is seldom uniform, and the observer generally confines his attention to the boundary of one part of the pattern, and adjusts for the disappearance of that part only. The complication of the pattern defeats its own object. The instrument is a fatiguing one to work with, not only because the observer can only use one eye, but on account of the use of an eyepiece, and the necessity of focussing. The telescope or microscope is considered to be an indispensible adjunct to any scientific instrument in Germany. Mr. J. S. Dow has shown* that with coloured lights, very considerable differences in the apparent balance may be produced by varying the adjustment of the microscope. Perhaps an excuse for using this with a Lummer-Brodhun photometer is that the field is rather small, and may with advantage be magnified.

Partly in order to reduce the fatigue, and partly to facilitate the comparison of different coloured light, a further modification has been introduced by shading one half of each prism by a strip of plain glass about 1 millimetre thick. These absorb from 4 to 8 per cent of the light, and the result is that the trapezoidal patches are rather darker than the rest of the field. When a balance is effected, with lights of similar colour, the central dividing boundary should disappear, and the trapezoids should present similar contrasts with the field on which they appear. As with most photometers, the whole box must be turned about a horizontal axis to avoid error from want of symmetry. This axis, XX in the illustration, must pass through the surfaces of contact of the prisms, and through the middle of the screen. It is advisable also to try the effect of reversing the screen only. If on reversal a different setting is obtained, a mean must be taken between the two readings.

The Lummer-Brodhun photometer is essentially a laboratory instrument, To claim that in its most elaborate form it yields over three times the accuracy of a Bunsen photometer for lights of similar colour, does not mean that it is "three times as good" as a Bunsen. It means that those who wish to reduce the probable error of an observation to a little less than one half of 1 per cent, and can secure the conditions for

* Proc. Physical Society of London. May 25, 1906. Vol. XX., p. 250.

such work by avoiding other sources of error (such as a variation of 1 part in 1,000 of the volts applied to a carbon glow-lamp, or a difference of 0.16 of a millimetre in the height of the flame of a Hefner lamp) may, if they have sufficient skill, attain this result by using a Lummer-Brodhun photometer.

A balance which will weigh a pound to an accuracy of a quarter of an ounce may serve for ordinary use in a foundry but in a laboratory attached to that foundry such a balance would be useless, and an instrument of greater accuracy and much greater complication of construction and liability to derangement will be found. Such a balance is suitable for the laboratory, but to use it for weighing castings in the foundry would be a waste of accuracy, time, and money.

(*To be continued.*)

The Illumination of Photometrical Laboratories.

It may seem strange that in a photometrical laboratory, where the actual testing of lighting sources is in progress, the principles of illumination should be neglected, but this is not infrequently found to be the case.

The deficient system of illumination may be partially due to the fact that the walls and all surrounding objects are commonly blackened, and therefore, render very little assistance in the way of reflecting light. Consequently, if a lamp is badly placed, the evil results are accentuated; all the light comes from the wrong direction, and shadows are caused which interfere with the person experimenting whenever he tries to write or to adjust any piece of apparatus.

In reality, the details of the lighting of such a laboratory ought to receive very careful thought. There ought to be local lighting from a well-screened lamp at the table where a worker may be engaged on the entry of results, and provision for the illumination of the dials of any instruments which he will find it necessary to read in the course of his experiments. Moreover —and this is a matter which one would hardly imagine necessary to draw attention to, but is yet often neglected —there ought to be provision for the illumination of the scale of the bench immediately below the photometer. This last point can be secured by a little ingenuity; for instance, a mirror is often useful to reflect the light from one of the sources tested on to the portion of the scale to be read, and right angle prisms are sometimes used for the same purpose. Where local lights are used it need not be pointed out that they should be provided with suitable screens or reflectors throwing the light on the objects to be seen, but screening the actual source from the operator. Also, for the reasons explained above, it is necessary to provide a sufficient number of sources, and correctly placed, in order that the worker may not be hampered by his own shadow when examining the mechanism of arc lamps, &c., and the light should come from the requisite different directions.

Above all, when we remember that the whole success of photometry depends on the ability of the eye to appreciate fine distinctions in light and shade, one can readily understand how important it is to protect our eyes from any possibility of glare, such as will spoil their sensitiveness.

For this reason, not only should the actual source tested be entirely screened from the observer's view, but the general lighting should be such that, when the lamps are switched on, no direct rays can ever reach the eye of the operator seated at the photometrical bench. It is, indeed, recognized to be far better for him to confine himself to taking photometrical readings, and for a second observer to carry out all other work that demands the use of such lights.

The Formation of the Illuminating Engineering Society.

An informal dinner was held at the Criterion Restaurant, Piccadilly, London, W., on February 9th, at which the formation of an Illuminating Engineering Society in this country was the subject of discussion, **Mr. Leon Gaster** presiding.

At this gathering representatives of the engineering, architectural, medical, and other interested professions, were present.

At the conclusion of the dinner, Mr. Gaster extended a hearty welcome to those present on this occasion as supporters of the movement which they all had so much at heart.

He then referred briefly to those who had expressed their sympathy with the movement, but for one reason or another were unable to be present, including among others: Sir Edward Brabrook, Mr. W. J. A. Butterfield, Mr. C. Carpenter, Dr. C. V. Drysdale, Prof. J. Fleming, Mr. F. W. Goodenough, Mr. A. Kitson, Prof. V. Lewes, Mr. C. le Maistre, Sir Joseph Swan, Mr. A. P. Trotter, Mr. A. A. Voysey, Mr. P. J. Waldram, Mr. W. H. Y. Webber, and many others.

Mr. Gaster then remarked that they had all already had an opportunity of learning the aims and objects of the Illuminating Engineering movement, and it would only require a few words from him to explain the basis of the suggestion that we should form an Illuminating Engineering Society in this country.

He felt sure that he would have their sympathy in this matter, and desired first of all to give a short summary of the efforts that he had made with this intention and their results.

It was now just three years since he wrote an article dealing with the need for the Illuminating Engineer. On this occasion he invited those interested to assist in this movement for the formation of an Illuminating Engineering Society, and at that time he had hoped that we, in this country, might have taken the lead in this matter. Since then it had so happened that the United States had taken the first move, and a very successful move it had been. Nevertheless, he hoped and believed that our work in this country might be as good, or perhaps even better, for we had the advantage of having learned from their experience.

His invitation on this occasion received many replies, mainly, however, from representatives of the Electrical Engineering profession, and therefore, though it would no doubt have been feasible to form a Society, he felt that it would not be truly representative of different methods of lighting and different professions, and consequently postponed the inauguration until the idea was more ripe.

About two years ago he had also had an opportunity of coming into contact with the leaders of the Illuminating Engineering movement in the United States, and so was kept informed of each step in the progress of their movement. The society in that country was started in December, 1905, with a membership of 93. In the short time that has elapsed since then this membership had grown to 1,000 and there were now several local branches of the society. In order, however, to perceive the true situation for himself, he undertook a journey to the United States.

During his visit he interviewed almost every man of note in connexion with the Illuminating Engineering movement, and received a cordial welcome and interviews which considerably facilitated his inquiries.

Subsequently he visited Philadelphia, Boston, Niagara, Washington, &c. He had interviewed among others Prof. Chandler, Prof. Elihu Thomson, Dr. Steinmetz, Mr. Stickney, Dr. Clayton Sharp, Mr. Marks, Mr. Weaver, Mr. Martin, Mr. Moore, &c., and was also present at meetings of the Institution

of Electrical Engineers, and of the Illuminating Engineering Society. He had had, therefore, ample opportunity of observing the earnestness with which the movement there was being taken up.

On his return he undertook a lengthy journey to the Continent, in order to secure the co-operation of the most important authorities on lighting, and he was glad to say that he had received a very hearty response, practically every expert of note having signified his cordial approval of his intentions.

Previously, he had been approached to undertake the editorial duties of the European *Illuminating Engineer*, to be published in London. Having ascertained that he could rely upon sympathetic support at the hands of those whose knowledge on these subjects was of value, he undertook the editorship of this journal in January of last year. Since then they had had an opportunity of ascertaining for themselves the wide scope there was for the study of the subject, and the number of articles which had appeared in this journal must have satisfied even the most sceptical as to the true nature of their aims and intentions, and the legitimate nature of the methods adopted of carrying them out.

In their movement, as in every movement, they must have a number of leaders before an appeal can be made to the masses. He had, therefore, endeavoured in the journal to appeal to the scientists and to the better educated engineers, so that once there was agreement as to the necessity of spreading the knowledge of illumination, the public, who were the consumers, would gradually be educated by those pioneers who at present formed the bulk of the readers of our magazine. The many encouraging letters which he had received since the issue of the magazine were too numerous for individual mention, and the comments of the press, representative of the different trades and professions interested in illumination had been throughout extremely cordial.

The number of collaborators of the journal now exceeded 140; it was representative of all the many branches of the Illuminating Engineering movement, and assisted by helpers in Europe, the United States, and even as far East as Japan.

Recently he had again been approached by those who were desirous of joining and forming an Illuminating Engineering Society, it being represented to him that the discussion that had taken place in the technical press, the publication of the American and English Illuminating Engineer, and in particular the *Transactions* of the Illuminating Engineering Society, had made the position much clearer; therefore an early opportunity should be afforded for the starting of a society in this country.

Of course, one of the chief questions that immediately arose was, How could such a Society be made self-supporting? How could you find a sufficient number of interested people to bear the expense of publishing the transactions or proceedings?

Well, as to this question, he could give a very satisfactory answer. He had approached his colleagues, the directors of the Illuminating Engineering Publishing Co., and asked them whether they would allow *The Illuminating Engineer* to become the official organ in the event of such a society being formed, thereby saving at a stroke one of the biggest expenses to the Society, and rendering possible its existence with a very limited number of members.

They would therefore agree that they are starting a Society under exceptionally favourable conditions, with indeed almost an ideal state of affairs, by having such trifling liabilities. He might mention that Dr. Bell, Past President of the Illuminating Engineering Society of New York, and also Mr. Lansingh, the general secretary, both had an opportunity, when visiting this country last year, of examining in detail the work undertaken by the journal. They were so well satisfied that at the second annual convention of the American Society, held this year in Philadelphia, the journal was appointed to receive the official manuscript of the proceedings for publication

simultaneously with that of their own transactions. This was a very great recognition. Having obtained this official standing he was glad to inform them that they could be in a position to make arrangements for the discussion of papers brought forward in America at the meetings of the Society in this country; thus, from a combination of the discussions in both countries, they would be able to judge the relative progress in any particular movement.

He anticipated, therefore, that the subscription to the Society would be very small, and would, of course, entitle members to receive the journal free, and to be present at all meetings of the Society.

The question had also been asked: "Where will you get enough matter to discuss?" No one, he ventured to think, who had really followed the subject, would be troubled by the suggestion. There was, however, the work of over three years of the American Society to fall back upon if needed, and the past publications of *The Illuminating Engineer* alone would bring up sufficient topics for discussion.

There was one point which must be made clear at the very beginning, namely, that the Society would not be called The Society of Illuminating Engineers, but the *Illuminating Engineering Society*. This meant that any one interested in the subject of lighting could join the Society but membership would not carry with it any professional status; in this respect it would resemble the British Association, the Royal Society of Arts, or the British Science Guild, for any one might become a member so long as he payed his subscription and was interested in the subject. He ventured to hope that in the future the Society would be very influential, and would do very valuable work. He only desired an impartial platform where the question of illumination, which, curiously enough, had hitherto been regarded as no one's particular business, could be freely discussed and made the subject of careful study.

Of the benefit of study of this kind there could be no doubt. The number of people with various defects of sight seemed to have increased enormously of late years. Present industrial conditions were such that people were bound to read much more than formerly and to transform night into day in order to gain a mere livelihood; anything that we could do to lighten this burden, therefore, by giving them the right amount of illumination in schools, libraries, offices, or factories, as the case might be, was worth doing; the task was a humane one, but only by co-operation could we obtain the desired results.

Mr. Gaster concluded by remarking that he had said enough to show that those present had little to risk and, like the general public, much to gain through the formation of an Illuminating Engineering Society on the lines indicated, and he relied upon their cordial assistance and co-operation.

After this speech the subject of the formation of an Illuminating Engineering Society was open for discussion, and we give, in what follows, a brief summary of the remarks made in connexion with the different toasts and proposals put forward.

Mr. J. Defries then rose to propose the toast of co-operation between those interested in different aspects of illumination, coupled with the names of Dr. H. Parsons, representing the oculists, Mr. S. D. Chalmers, for the physicists and the optical industry, Mr. J. Darch, connected with the architectural profession, and Mr. A. E. Penn, representing the Society of Engineers in charge.

Mr. Defries expressed his appreciation of the high ideals which Mr. Gaster was endeavouring to materialize, and his sense of the value of co-operation between those representing different professions. He had been often struck by the difficulty in securing really reliable data on points connected with illumination, and felt that co-operation between different professions in order to supply these missing links was needful.

On the other hand, he had recognized that the bringing together of those representing gas, electricity, &c., was

a stupendous task, which only Mr. Gaster's indomitable and invincible energy could accomplish.

However, such representatives were assembled together in friendly discussion to-night, and he hoped that it might be found possible to continue this rapprochement even when they were not present at such a festive board.

Holding as he did that co-operation was so very needful, he had great pleasure in coupling this toast with the name of Dr. H. Parsons, who, he understood, was already interested in researches on the effect of light on the eye. This, of course, was a matter which ought to have been taken up long ago, and he hoped that Dr. Parsons would give valuable information on the subject, and make further researches in the future.

He had also pleasure in mentioning the names of Mr. S. D. Chalmers as representing the physical aspects of the optical industry, and Mr. J. Darch, who, he understood, was interested in church and school lighting—both exceedingly important subjects. Mr. A. E. Penn, as many of those present would know, was the Chairman of the Educational Committee of the Society of Engineers in Charge, and he thought it particularly fitting that a representative of this society, with such wide interests, should be present. (Applaus.)

Dr. H. Parsons, in reply, fully agreed that the study of the physiological effect of illumination, as apart from its actual luminous efficiency, did not receive enough attention. He himself had become interested in the subject through the effect of ultraviolet light on the eye, and the possibility of cataract, which occurred among those working in glass furnaces, being attributable to this cause. This was a typically difficult question on which the co-operation of physicists, chemists, and physiologists was needed. On such a subject very few reliable data were as yet available.

He quite agreed with Mr. Defries that the subject of the physiological effect of light ought to have been taken up long ago. Some attention had been paid to the subject by the medical profession, but their views were not sufficiently impressed upon engineers. He therefore felt that a society on the lines proposed by Mr. Gaster might do very valuable work in spreading such knowledge.

Mr. S. D. Chalmers said that he felt there was very much more to be learnt about the physics of light production, and the manufacture and use of light in such a way as to be most useful for general illumination.

He added that the earliest engineering work with which he had been associated was the design of the optical systems of lighthouses, and this had led him to study the subject of illumination in more detail. He thought that great benefit would result from the formation of such a society, and wished it every success.

Mr. J. Darch said that in his experience the study of illumination and the choice of illuminants was of very great importance. He had tried time after time to impress this view on those with whom he came in contact, but had found a great deal of prejudice to contend against.

He felt that the sympathetic co-operation of those joining the Society proposed by Mr. Gaster would be a great force in this direction, and he, for his part, would be very willing to do what he could to help the movement forward. He hoped that the medical profession would be well represented because their interest in this matter was very vital, and their influence among a certain section of the public would be exceedingly great.

Mr. A. E. Penn was very glad that Mr. Gaster had afforded him an opportunity of expressing his appreciation of the proposed Society. The Society of Engineers in Charge, with which he was connected, was continually aiming at fraternization, and the engineer in charge himself, was always anxious to learn what a specialist in any department had to tell him.

It gave him great pleasure to feel that Mr. Gaster's efforts were to be crowned with the success which his energy deserved.

Mr. H. T. Harrison rose to propose the toast of the Illuminating Engineer-

ing profession, coupled with the name of Mr. J. S. Dow. He had always admired Mr. Gaster's boldness in attempting to form a Society, and was glad that this great need was now about to be fulfilled. Mr. Gaster was trying to do something which had never been done before, and his efforts deserved every success; it was true that good ideas did not always receive the success they deserved, but he hoped and believed that this would be the case in connexion with the movement for which Mr. Gaster had worked so hard.

He himself had been brought up as an electrical engineer, and had taken up the question of street lighting. He had continually been impressed with the need of some impartial authority to weigh the claims of those connected with different systems of lighting, who were, not unnaturally, prejudiced in favour of their own illuminants.

In the course of his work he had also come to the conclusion that it was necessary that these questions should be attacked on the basis of actual measurement of the illumination provided, and therefore he was led to take an interest in the subject of photometry. In this connexion he had read with interest some papers published by Mr. Dow, and it gave him great pleasure to couple Mr. Dow's name with the toast of the Illuminating Engineering profession which, he hoped, would come into existence this night.

Mr. Kenelm Edgcumbe said that he had not anticipated having to make a speech; he was, however, obliged to Mr. Gaster for deferring his intimation to this effect until dinner was over. His own experience had been chiefly in connexion with measuring instruments and photometry. He himself was able to look at the question from an impartial standpoint, and he felt that it would be a great thing both for the industry and the general public if we could meet together and discuss these questions.

He had recently been struck by some work of Mr. P. J. Waldram, who, he understood, was to have been present to-night, in connexion with daylight measurement; Mr. Waldram had shown the value of photometry in deciding questions relating to ancient lights. He was particularly interested to learn that Mr. Waldram had been able to apply this method to the actual demonstration of the truth in his contentions in cases of this description in court. This was one illustration of the unexpected directions in which the need for light measurement was constantly being experienced.

It gave him great pleasure to second the toast proposed by Mr. Harrison, and to couple it with the name of Mr. Dow, who had done much preliminary work in this subject.

Mr. J. S. Dow said that he was impressed by the responsibility in replying on behalf of a profession which did not as yet exist, and of which, therefore, he had no right to call himself a member. He was, however, he believed, one of the first to express his sympathy with Mr. Gaster's proposed Society three years ago, and he was in hearty sympathy with the movement.

In attempting the study of photometry and kindred questions, he had been very much struck by the exceedingly scattered nature of the data available. One had to toil through the proceedings of very many different British and Foreign Societies, and at the end of it usually found that the data were expressed from some narrow point of view, which prevented them being properly comparable among themselves.

As an illustration of the fact that the very term "illumination," in the sense in which we use it, was almost unknown until recently, he might mention that when he looked up its use in a well known encyclopædia, he was rewarded by the cryptic reference "Illumination. *See* Fireworks." He thought, however, that the great aim of the Society would be, as Mr. Defries had stated, to promote co-operation. The time had come when no really important general investigation could be carried to a successful conclusion, except by the concerted efforts of workers in the different fields interested.

There had been some complaints that illuminating engineering was over-specialization. Yet it might more fitly be said that "illuminating engineering was amalgamation," for it brought into contact very many people who worked in their own narrow circle and developed ideas without considering how they effected those interested in other aspects.

If, for this reason alone, he thought there need be no lack of subjects to deal with or members to deal with them. Light and illumination were of such general interest that the Illuminating Engineering Society would be unlike a purely technical Society in that it might deal with questions of vital interest to the general public. It might be found desirable, for instance, to have one night devoted to the eye, when the medical profession would attend in force, another to electric light fittings, when those interested mainly in this section, and architects and others might be expected, and so on. Besides the central body of those who wished to make illuminating engineering their main interest, there would be many others who would be members of the Society because of its connexion with their own particular field.

In conclusion, he wished to echo all that Mr. Harrison and others had said of Mr. Gaster's devotion to the movement, and it was no disparagement to Mr. Gaster's efforts to point out that this was in no sense a "one man show," for Mr. Gaster's boundless enthusiasm had now infected so many others that the movement seemed bound to proceed.

He thanked Mr. Harrison and Mr. Edgcumbe for their kind reference to himself, and hoped that each one of those present would co-operate in order to render the Society a success.

Mr. Charles Hastings said that for the last quarter of a century he had been interested in illumination, and had followed the progress of the Journal of which Mr. Gaster was the editor, with great interest; he had always believed in the necessity for the study of illumination, though he had been less convinced of the necessity for the Illuminating Engineer. After hearing what had been said on the subject this evening, however, he must now confess that he was convinced, and was particularly struck with the need for somebody to bring out the study of the *use* of illumination as apart from its production—in other words, the need of the illuminating engineer.

He had admired the way in which this aspect was brought forward in Mr. Gaster's excellent journal. Now a Society could have little influence unless it possessed some means of making its views known; there must be an official organ. He had therefore much pleasure in proposing that *The Illuminating Engineer*, published in London, be appointed the official organ of the Society, and he felt sure that all those present would appreciate the benefit of having a responsible magazine in which members could communicate with one another, and which had already won such a high position.

Mr. A. Denman Jones felt that there was no need to add anything to what had been said with regard to the formation of the Society, but was surprised to find how much he had in common with others in wishing the welfare of this movement. He had much pleasure in seconding Mr. Hastings's proposal.

This proposal was coupled with the name of **Col. Leese** as the Chairman of the Illuminating Engineering Publishing Co., Ltd., who was unfortunately absent owing to indisposition. In his absence **Mr. Gaster**, as Co-director, thanked Mr. Hastings and Mr. A. Denman Jones for their kind remarks in connexion with the magazine.

It having been proposed by **Mr. Charles Hastings** and seconded by **Mr. A. Denman Jones** that "*The Illuminating Engineer* (London) be appointed the official organ of the Illuminating Engineering Society in this country," this proposal was put to the vote, and carried unanimously.

Mr. Gaster, in expressing his satisfaction at the sympathetic remarks of those who had spoken regarding the proposed Society, said that it had made this one of the happiest days of his life to see this Illuminating Engineering Society coming into existence.

Incidentally he mentioned that by a curious chance this dinner was held on his birthday.

Mr. Gaster's health was then drunk by those present with musical honours.

Mr. Justus Eck remarked that much had been said in praise of Mr. Gaster that was thoroughly deserved.

The proposal which he had now to make was that a provisional executive committee be appointed to prepare the statutes of the Society and to do any special work in facilitating the inaugural meeting. He proposed, further, that the gentlemen present to-night, together with those who had accepted but were unable to be present, should serve as an informal committee of this kind.

Mr. J. W. Ife seconded the proposal. Service on this committee would not entail any onerous duties.

With regard to the future of this Society, he felt convinced that there would be no difficulty in securing a membership of 100 or more very shortly, and had no doubt that, this point being reached, the number would soon be swelled to 500. The American Society, who had had exactly the same initial difficulties to contend against as in this country had increased their membership to 1,000 in two years.

Mr. Gaster then remarked that the present company was thoroughly representative, and so fulfilled the necessary qualification for an informal committee; officers, &c., could be appointed afterwards.

The proposal before those present was then put and carried unanimously.

Mr. H. T. Harrison proposed that a small sub-committee be appointed to assist in drawing up rules, and proposed Mr. Gaster as chairman of the sub-committee.

Mr. Gaster expressed his sense of this honour, but said that he would rather take up the work of honorary secretary, and proposed Dr. H. Parsons as chairman. Subsequently the following gentlemen agreed to act on this committee :—

Dr. H. Parsons, Mr. J. Eck, Mr. H. T. Harrison, Mr. C. Hastings, Mr. J. Darch, Mr. J. W. Ife, with **Mr. Leon Gaster** as Hon. Secretary, it being understood that others might be coopted as the committee might think fit.

In conclusion, **Mr. Ife** proposed the toast of the technical press. He remarked that the company to-night was, indeed, as Mr. Gaster had remarked, representative of many different professions and interests. Whatever our interests, however, we could not avoid connexion with the technical press, and he had pleasure in proposing this toast, which was seconded by Mr. Cox, and coupled with the name of Mr. Charles Hastings.

Mr. Hastings said he was glad to extend the hand of fellowship to those representing other technical journals. He felt, however, that all alike, whether connected with gas or other periodicals, had much to learn on the subject of illumination.

Mr. Defries then proposed the health of **Mr. Gaster**, which was drunk with enthusiasm. He could only compare Mr. Gaster's enthusiasm and energy to a fire-engine coming down a great thoroughfare; it was an inspiring spectacle. Many happy returns of the day to him.

Mr. Gaster, in reply, thanked all those present once more for their support from the bottom of his heart. Before parting he would like to emphasize once more what he felt was the keynote of the whole position, namely, co-operation.

The dinner terminated about 10.45, but many of those present remained discussing the subjects brought up in the course of the evening until past 11.

At this dinner the following gentlemen were present: Mr. G. Barham, Mr. F. J. Cox, Mr. S. D. Chalmers, Mr. J. Darch, Mr. W. Defries, Mr. A. Denman Jones, Mr. J. S. Dow, Mr. H. J. Eck, Mr. K. Edgcumbe, Mr. F. W. Fairbrother, Dr. A. Gaster, Mr. L. Gaster, Mr. H. T. Harrison, Mr. C. W. Hastings, Mr. J. W. Ife, Mr. E. C. Laughton, Dr. D. A. Louis, Dr. R. Lessing, Mr. W. Okey, Dr. J. H. Parsons, Mr. M. Pal, Mr. A. E. Penn, Dr. H. Schwabacher, Mr. Strangways, Mr. H. S. Smith, Mr. H. C. Wheat.

Gentlemen interested in the Society are requested to communicate with **Mr. L. Gaster,** 32, Victoria Street, London, S.W.

Modern Methods of Illumination.

By Leon Gaster.

(Editor of *The Illuminating Engineer.*)

(The following is the Syllabus of four Cantor Lectures to be delivered before the Royal Society of Arts, Adelphi, W.C., on Monday Evenings, February 15th, 22nd, March 1st, 8th, at 8 o'clock, the first of which we abstract in this number, by kind permission of the Society.)

Lecture I.—*February* 15.—Electric Lighting.—Introduction—Incandescent Electric Lamps (Historical Summary)—Recent Developments of Nernst—Graphitized, Tantalum, Osmium, Tungsten, Helion, Mercury Carbon, and other Lamps—The Use of Transformers—Effect on the Lighting Industry (Central Stations, Manufacturers, and Consumers)—National Lamp Association and Standard Specification—Lines of Future Development. *Arc-Lamps.*—The Carbon Arc—Open and Enclosed Arc-Lamps—Miniature Arc-Lamps—Flame-Arc Lamps—Open and Enclosed with Inclined and Perpendicular Carbons—Arc-Lamps for Photographic and Medical Purposes—Applications and lines of Future Progress. *Use of Luminescent Vapour and Gases.*—Early Mercury Lamps—Cooper-Hewitt, Bastian, Vogel, Quartz-Tube, Küch, and Uviol Lamps—The Moore System of Luminescent Gases and its Applications.

Lecture II.—*February* 22.—Gas-Lighting.—Summary of Early Development of Gas-Lighting—Flat-Flame, Regenerative, and Enriched Gas-Burners—The Coming of the Incandescent Gas Mantle—Its Theory and Action—Soft Mantles and other New Developments—The Hella Bushlight. *High-Pressure Gas-Lighting.*—Selas, Millenium, Sale-Onslow, Pharos, Grätzin, Colonia, Keith-Blackman, Suggs, and other Lamps—Relative Merits of Compressed Air, Compressed Gas, and Mixture of Air and Gas—Self-Intensifying Lamps, Scott-Snell, Lucas-Thermopile, Welsbach, Chipperfield Lamps, &c. Automatic Lighting and Extinguishing at a Distance—Electrical and Pneumatic Devices—Self-Lighting Mantles—Liquid Gas—Blau, Wolf, and other Systems—Modern Problems in Gas-Lighting—Recent Developments in Street Lighting in London and Berlin—Candle-Power Standards *versus* Calorific Power of Gas—Lines of Further Researches: Livesey Professorship at Leeds.

Lecture III.—*March* 1.—Lighting by Candles, Oil, Acetylene, Petrol, Air-Gas, Alcohol, and other Illuminants.—The Candle and other Early Systems—The Petroleum Lamp: its Merits and Drawbacks; Decision of Third International Petroleum Congress *re* Safety of Lamps—Recommendations of using Efficiently the Ordinary Household Lamp—The Petrolite Lamp—High-Pressure Systems of Kitson, &c.—Modern Petrol Air-Gas Systems and their Merits—Examples of several Types and Generators—The Aerogen, Cox Air-Plant, De Laitte, National Air-Gas, &c.—Lighting by Alcohol and other Liquid Fuels—Acetylene: its Early Development and Difficulties Overcome—Modern Types of Burners—Applications to Incandescent Mantles—Liquid Acetylene—Transport Facilities—Lighting of Railway Carriages—Illumination of Buoys, &c.—Summary of Position of Modern Illuminants—Comparisons of Quality for Lighting and Radiant Efficiency—Researches for further Improvements.

Lecture IV.—*March* 8.—General Problems in Illumination and Illumination Measurements.—Daylight Illumination and its Variation during the Day and Season of the Year—Intrinsic Brilliancy of the Different Artificial Illuminants—Effect on the Eye—Methods of shading, Use of Frosted Opal and Holophane Globes and Reflectors—Spectra of various Illuminants—Possible Physiological Effects of Light of Different Colours—New Researches of Effect of Ultra-Violet Light on Sight—The Use of Euphos glass—Modern Methods of Measuring Light and Illumination: Exhibition of some of the Latest Apparatus—International Action regarding Standards and Units of Light—Lighting of Schools, Libraries, Factories, Hospitals, &c.—Illumination and Hygiene—The Work of the Illuminating Engineering Society—The Need of the Illuminating Engineer Expert: Description of his Functions—Concluding Remarks and Recommendations.

Each lecture will be fully illustrated by working specimens of the lamps and apparatus described.

Modern Methods of Illumination.

I.—Electric Lighting.

By Leon Gaster.

(Cantor Lecture delivered before the Royal Society of Arts on February 15th, 1909; the following abstract is made by kind permission of the Royal Society of Arts.)

Mr. Gaster delivered the first of a series of Cantor Lectures before the Royal Society of Arts on Feb. 15th, the subject being 'Electric Lighting.'

In commencing his remarks, Mr. Gaster referred to the vastness of the subject, and explained that in the course of his lecture he could only deal with a few salient points in a general manner, but that he proposed to deal with the matter in greater detail when the lecture came to be published in the *Journal* of the Royal Society of Arts.

Mr. Gaster proceeded to allude to the invaluable work carried out by the Royal Society of Arts in the past on the subject of illumination, which had always been considered on an impartial basis, attention invariably being drawn to each new development, whatever its nature, as it occurred.

He next made a few remarks on the historical development of illumination, dwelling on the state of the streets of London before gas and electricity were introduced, and pointing out what a marked development in the *colour* of illuminants, as well as in intensity, had taken place ; the camp-fires and ruddy torches of the Romans had given place to the incandescent gaslights, metallic filament glow-lamps, flame-arcs, and mercury-vapour lamps, &c., of the present day.

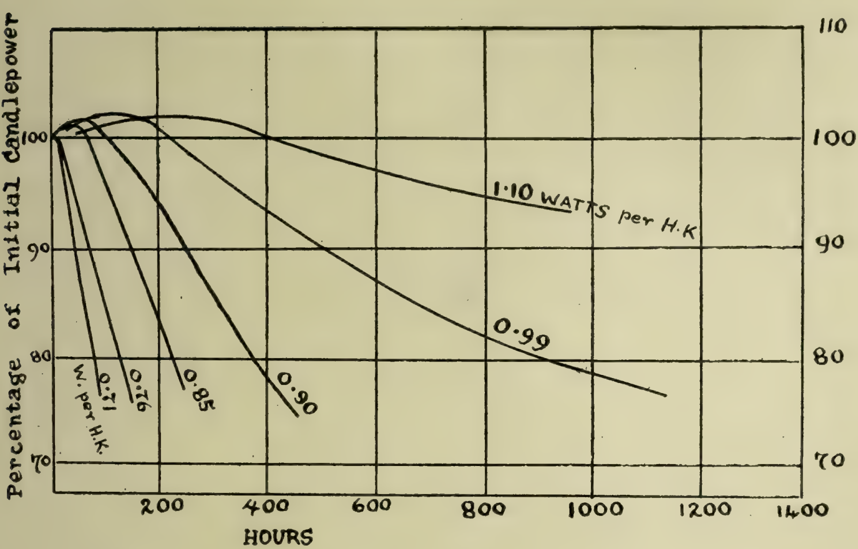
Step by step with this development in methods of illumination had been the spread of education and the increase in printed matter. We now turned night into day with an ease which our forefathers might, or might not, have envied, but would certainly have thought incredible ; therefore it was all the more essential to consider what form of illumination was most suited to the eye. In this connexion the lecturer threw a few slides on the screen illustrating the complexity of this organ, and pointed out how so elaborate a piece of apparatus needed careful study by those engaged in lighting problems.

After these preliminary remarks, Mr. Gaster turned to the consideration of recent developments in electric lighting, and quoted as a fitting introduction the following extract from Mr. Swinburne's Presidential Address before the Institution of Electrical Engineers in 1902 :—

"Our chief work, until lately, has been producing light. Here the inefficiency and waste is prodigious, and, though it is mostly unavoidable, there is still great room for improvement. We take great care over our stations, watching every penny from the coal shovel or mechanical stoker to the station meter. We quarrel over 1 per cent. in the generators. When we get to the mains we care less, and once we get to the customers' meters we care nothing at all."

Since the date of Mr. Swinburne's address we had seen a wonderful development in electrical illuminants. It might seem strange to reflect that from about the year 1870, when the first practical incandescent lamps were introduced, until a few years ago, when metallic filament lamps came upon the scene, the actual construction of the carbon filament lamp should have remained so essentially the same. Yet we must remember that there were wide gaps in our knowledge of the lamps which have since been utilized so successfully, which had to be bridged before they could be turned to practical account.

Mr. Gaster then referred briefly to the various attempts to improve the efficiency of glow-lamps, explaining that he only wished to dwell on the new developments that had come about since his lecture before this Society in 1906.



Performances of Tungsten Lamps at different Watts C.P.

(Remanè, Verband Deutsch. Elektrot ,1908)

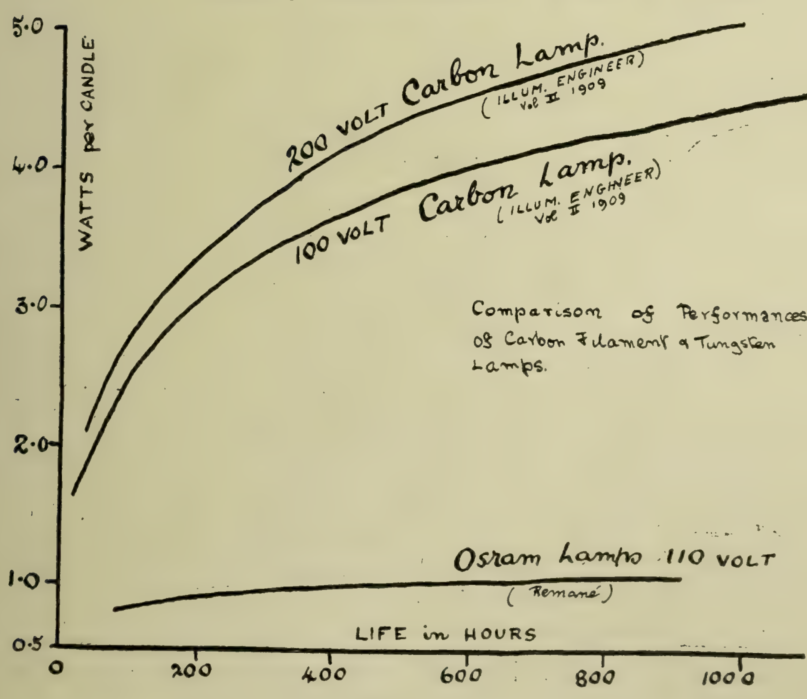


Fig 1.

Glow-Lamps.

One of the earliest attempts to improve electric incandescent lighting had been the Nernst lamp, which was, of course, well-known. Its chief disadvantage had been the complexity of the heating coil, &c., and he understood that experiments were being made with the object of producing a filament which should be "self-starting." He then exhibited one of the newest types of lamps of the Electrical Co. for 200 volts, yielding a candle-power of 1,000, produced by three horizontal glowers.

One of the first of the series of metallic filament lamps was the Osmium lamp, introduced by Auer Von Welsbach. The brittleness of the filament and other defects, however, prevented its commercial development on a large scale. Filaments had also been made of a another metal in the same group iridium; but these lamps, too, were only made for very low voltages, for motor-cars, &c.

The tantalum lamps utilized a drawn wire of metallic tantalum, and the lamps had usually a life of about 600–800 hours at an efficiency of 1·8 to 2·2 watts per candle respectively. An exhibit of the most recent types of lamps of Messrs. Siemens & Co. was then referred to; to this company belonged the credit of producing a 100-volt 16 candle-power lamp, and it was expected that further developments, possibly a 12 candle-power lamp, would follow shortly. The tantalum lamp was not so suitable for alternating P.D.'s as for direct current; he had made inquiries on this point, and was informed that although experiments to overcome this difficulty were being carried out, and had had some success, it was still found preferable not to run alternating lamps at so high an efficiency as those for direct current.

Reference was then made to the graphitized filaments of Howell (*Proc. of Amer. I.E.E.* 24, p. 617, 1905), in which a specially prepared carbon filament capable of running at 2·5 watts per candle-power was obtained, and represented a marked advance. There were still many authorities who believed that the efficient lamp of the future would have a carbon filament, and quite recently two German inventors had claimed to have made carbon filaments from the soot produced by carbonizing vegetable oils, and also from the materials used in Chinese inks, which would run for 1,000 hours at an efficiency of 1 watt per candle (*Zeit. f. Bel.*, Dec. 30, 1908).

Another interesting recent development was the Hopfelt lamp (*E.T.Z.*, Oct. 8th, 1908), which utilized a carbon filament burning in an atmosphere of mercury vapour. It was claimed that the high pressure of the latter reduced the tendency to disintegration on the part of the filament, and therefore enabled it to run at a consumption of about 1·5 watt per candle: this lamp was exhibited.

It was, however, as yet too early to speak of the possibilities of this lamp.

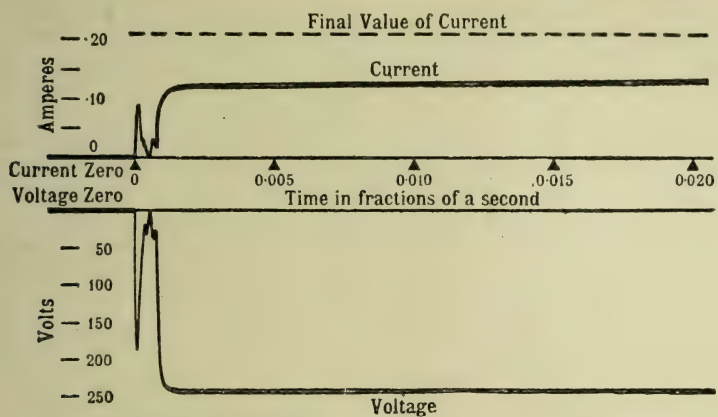
A very interesting type of lamp was the "Helion" lamp, developed by Parker & Clark in the United States. The filament of this lamp was supposed to consist mainly of silicon, which was deposited on a carbon core; M. Blondel (Congrès de Marseille, *loc cit.*) had advanced the suggestion that an eutectic alloy of carbon and silicon might be formed.

For this lamp a life of 1,000 hours at an efficiency of 1 watt per candle was said to be obtained; at the same time all the advantages of a high-resistance filament were claimed. More recently still the inventors had announced an improvement, enabling the filaments to be burnt in the ordinary atmosphere without a vacuum-bulb (*Elec. World*, N.Y., Sept. 5th, 1908); however, the lamps were as yet not commercially manufactured.

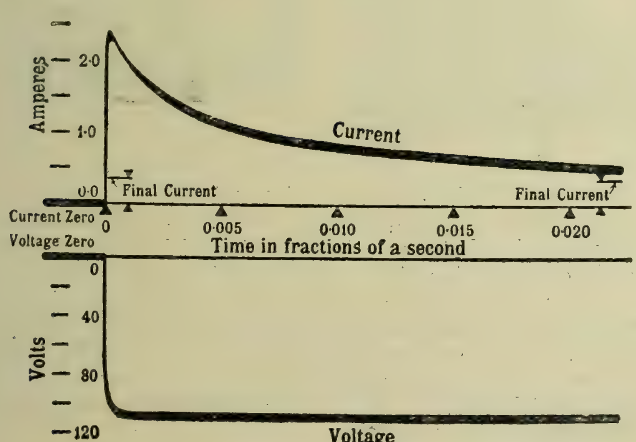
Mr. Gaster then referred to the tungsten lamps. These were made by many different processes, and called by distinct names, but though the actual materials were believed to be the subject of slight modification in the case of different firms, it seemed to be generally agreed that the metal tungsten was the chief basis of their composition. With the actual process of manufacture he could not deal in any detail, but might refer those interested to three recent contributions

by Prof. Blondel (Congrès de Marseille, 1908), and Dr. H. Weber, and Dr. F. Jacobsohn (*Illuminating Engineer*, vol. i. pp. 297, 395, 463), in which some very complete data were given.

Although it must be admitted that most of those methods originated in Germany and Austria, it was nevertheless true that much of the early pioneer work of electrical glow-lamps was



—Oscillogram of Starting Current in 220 v. 5 c.p. Carbon Filament Lamp.



—Oscillogram of Starting Current in a 110 v. 32 c.p. Osram Lamp.

Fig 2.—(Prof. J. T. Morris, *Electrician*, June 7th, 1907.)

When one considered the complexity of these different processes, and the extraordinary difficulties with which the manufacture of metallic filament lamps were encompassed, it was wonderful that such excellent results had been obtained.

carried out in England. At the present day, too, the manufacture of these lamps was being taken up with energy in this country. As an illustration of this fact, Mr. Gaster pointed to a large collection of metallic filament lamps on exhibition by the following firms ;—

Messrs. Boddy & Co., The Bryant Trading Syndicate, British Thomson-Houston Co., Edison & Swan, The Electrical Co., (Aegma), Messrs. Falk & Stadelman (Sirius-Effesca), The General Electric Co. (Osram), Messrs. Siemens Bros. (Tantalum), The Stearn Electric Co., The Sunbeam, The Westinghouse Co., and The "Z" Electrical Syndicate — many of which were manufactured entirely in this country.

It would be admitted that to produce a lamp which would run at little more than 1 watt per candle for 1,000 hours was in itself a remarkable achievement. Of course it would be possible to reduce this figure yet more if one were content to sacrifice the durability of the lamps. In this connexion some recent results by Remanè (*Verb. Deutch. Elektrot.*, 1908), showing the connexion between the useful life and consumption in watt per candle-power of metallic filament lamps run at different voltages would be of interest. In the same diagram were shown some corresponding results for carbon filament lamps.

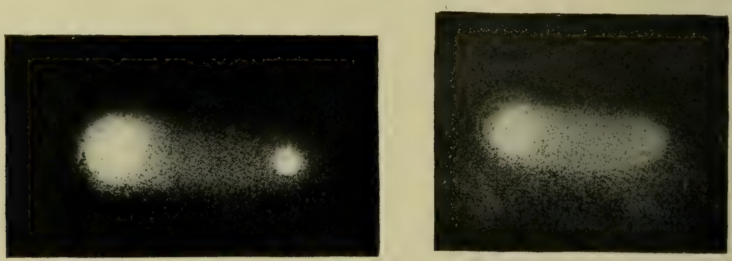


Fig. 3.
Ordinary Carbon Arc. Flame Arc.
(Andrews, Inst. of Elec. Engineers, 1906.)

It was worth remembering, however, that carbon filament lamps were now so cheap compared with the most efficient metallic ones, that it might sometimes be advisable to overrun them at say 2·5 watts per candle, so as to secure a higher efficiency, even though coupled with the loss of life. This point had been dwelt upon by a correspondent in *The Illuminating Engineer* (vol. i. December, 1908, vol. ii. January, February and March, 1909).

Mr. Gaster next proceeded to deal with some defects, or rather respects in which the manufacture of metallic filament lamps were still incomplete.

One of the main problems was still the production of a metallic filament lamp of high voltage and low candle-power. The low resistance of the metals used in these lamps compelled us to use very thin and very long filaments. For instance, a tantalum 220-volt 50 candle-power lamp was said to utilize wire of a diameter of only 0·04 mm., and it was a miracle of ingenuity to draw homogeneous wire so fine. Again, the Osram 220-volt 50 candle-power lamp involved filaments of the same order of diameter, and yet in the United States a 25-watt 100-volt lamp had already been produced. Yet from one point of view this difficulty was fortunate, because the too sudden introduction of lamps of low consumption would have an extremely disturbing effect on the electrical industry, so that the present conditions of things enabled us to tide over the inconvenient transition from the old carbon lamp to the low candle-power metallic one.

Another striking quality of metallic filament lamps was the fact that their resistance, unlike that of carbon, increased with temperature.

Partially owing to this change in resistance it was found that a given change in P.D. produced a smaller corresponding change in candle-power in the case of metallic filament lamps than in the case of carbon ones, which was advantageous, because it might mean that the amount of copper in a consumer's leads, for a given drop in P.D. might be reduced.

An interesting consequence of the way in which resistance in metallic filament lamps change with temperature was that the initial current through a tungsten lamp might be as much as eight times the final value, while in the case of a carbon lamp it was smaller. This was shown by some interesting oscillographic diagrams, due to Prof. J. T. Morris (*Electrician*, June 7th, 1907).

Indeed, it was said that the candle-power of a tungsten lamp, when switched on, actually exceeded its normal value for a very short time (Freeman, *Electrical World*, August 15, 1908). It was stated that the occasional habit of metallic filament lamps to burn out the moment they were switched on was partly due to this effect.

One interesting type of lamp recently brought out in Germany contained a small carbon filament in series with the main tungsten filament (see B. Duschnitz, *Illuminating Engineer*, vol. i. p. 817).

By this means the inconveniences resulting from being obliged to make a filament, perhaps 1,000 mm. long and, perhaps, 0·03 mm. in diameter, as is necessary in the case of a 220-volt 50 candle-power lamp, were claimed to be partially avoided, for the small carbon filaments supplied the required resistance, and enabled a lamp to be made which was said to consume about 1·5 watts per candle, and yet absorb less actual current than the 16 candle-power carbon filament lamp.

An incidental advantage in these lamps lay in the fact that the high cold resistance of the carbon filament prevented the initial rush of current characteristic of metallic filament lamps to some extent, the instantaneous current of switching being only twice its final value. This lamp was exhibited.

Reference was also made to he well-known Stearn "Leuconium" lamp exhibited. This lamp consisted of a number of low voltage filaments in series with one another, each being provided with a carbon filament which was automatically switched on if the tungsten filament fails. In this way the advantages of securing a strong and efficient low voltage tungsten filament were obtained.

Mr. Gaster next referred to the use of transformers with metallic filament lamps, pointing out that, though this system had undeniable advantages, it must not be applied indiscriminately, and was undesirable in a case in which the transformer would have to be in action continuously, even though only a few lamps were switched on. In instances in which all the lamps were put on together this last difficulty was not felt, and Weissman had devised a method of switching on a transformer with the low candle-power lamps fed by it, which was of service in connexion with sign-lighting, &c.

A few other drawbacks of metallic filament lamps referred to by Mr. Gaster were the question of breakage in transport, the occasional blackening of bad lamps, and the difficulty of burning lamps in any but a vertical position. It was gratifying to find that companies were now undertaking to renew lamps which failed unreasonably on account of the two first causes.

The last difficulty had been largely got over by the "Z" and other com-, panies, by providing a spring-loop capable of taking up the sag of the filament when it became hot and soft, and to-day many lamps for 200 volts and over, capable of burning in any position, could be obtained in this country. An experiment was then shown in which the actual filaments of a number of different types of lamps were thrown upon the screen, and the audience were able to see how, when the current was switched on, the sag of the filaments was taken up by spring loops in the various cases.

In conclusion, Mr. Gaster dwelt upon several respects in which the practice in the United States differed from that in this country, dwelling upon the system of co-operation between the supply-companies and the central stations, many of whom actually supplied lamps to their consumers, and advised them as to their best use.

Again, the question of the extraordinary diversity in the nature of the pressure supplied by different electrical companies in London was not experienced in the United States

to the same extent. As an illustration of the conditions in that country, Mr. Gaster referred to the work of the National Electric Light Association, maintained by a very large number of lamp-makers in the United States, who supported a common laboratory for the purpose of carrying out tests on glow-lamps for the common benefit. He also mentioned the farsighted action of the Boston Edison Electric Illuminating Co., to whom belonged the honour of being the first supply company to organize an expert staff of illuminating engineers under the supervision of Dr. Louis Bell, from whose advice consumer and company alike could benefit. This policy had been very successful. During the three months it had been in action 450

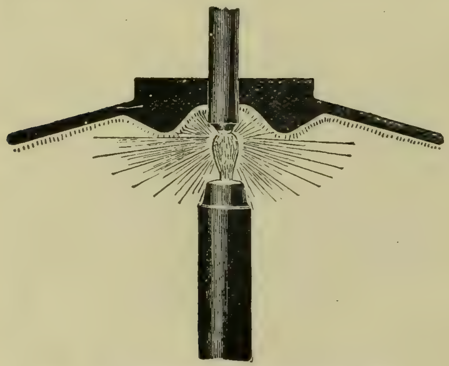


FIG 4.—Crompton-Blondel Arc, with Reflector.

applications for assistance, including 19 requests from churches in Boston, had been received.

Mr. Gaster next referred to the need for a standard specification for metallic filament lamps. Some experiments in this direction had been made in Germany, and with the increased cheapening of lamps and the accompanying increase in the number of inferior articles being put upon the market, this need would be keenly felt. One difficulty, however, was the fact that at present it was openly admitted that the P.D. at consumers' terminals was often very different from the nominal value; naturally, this made things very inconvenient for the lamp companies, and would greatly invalidate the value of a standard specification.

ARC LAMPS.

Mr. Gaster next turned to the subject of arc-lamps, again remarking on the wideness of the field to be covered. In the ordinary carbon arc the great majority of the light was thrown from a white hot crater on the positive carbon; under these circumstances we had to deal with an incandescent solid, in which necessarily many varieties of vibration, worthless from the luminous point of view, existed.

More recently, however, attempts had been made to utilise luminescent vapours by introducing a suitable volatile chemical core into the carbons. Under these circumstances the light was obtained mainly from a bridge of highly luminescent vapour.

The early carbons were not sufficiently homogeneous, and yielded a flickering light; in addition, the chemicals formed a non-conducting slag. This last difficulty was overcome by the introduction of inclined carbons.

Fig. 7 showed very clearly the distinction between the flame and the pure carbon arc, as described by Mr. Leonard Andrews in a paper about three years ago before the Institution of Electrical Engineers.

This system of inclined carbons had the advantage of avoiding the shadow from a negative carbon; on the other hand, the strong downward component of the light was not so favourable for street-lighting, and M. Blondel had, therefore, devised flame carbons capable of burning in a vertical position. Such lamps had been used with success in the streets of Berlin, and the Crompton-Blondel arc was an example of the use of the principle in this country.

Since the first introduction of a successful flame-arc by Bremmer, many different types of flame-arcs have been devised. Enormous candle-powers were obtained, but there was a difficulty in making lamps burn sufficiently long without recarboning. An ingenious method of meeting this device was the magazine lamp of the Oriflame type, in which each carbon was automatically replaced as it is used up.

A natural attempt to improve the flame-arc was to enclose it and to exclude air from the carbons. Un-

fortunately the deposition of the fumes on the globe of the lamp was found to be a drawback even in lamps of the ordinary kind. Recently, however, the Union Electric Co. had introduced a modification of the Duplex-Excello arc, enabling the fumes to be carried away and condensed outside the globe; they had also added a prismatic inner globe, which served to modify the natural curve of light distribution from the lamp, so as to render it more suitable for street-lighting. By using two pairs of carbons burning consecutively this lamp was said to burn for 34 hours without recarboning.

Very recently Mr. A. Denman Jones had brought out a type of enclosed flame-arc, by which the gases were completely removed, and long burning hours secured. This has been recently described in *The Illuminating Engineer* vol. i., p. 310).

Reference was next made to the Magnetite arc-lamp utilizing a negative electrode composed of a suitable mixture of Magnetite and Oxides of the raw metal Titanium and other substances. A very long luminous arc was obtained, the quality, however, of which depended entirely on the constitution of the negative electrode. The positive electrode merely consisted of a slab of copper. It had no influence on the quality of the light, nor did it waste away. The negative, however, wasted away at such a slow rate, that the lamp, it was said, could be burnt 500 hours without recarboning.

One interesting development in arc-lamps of recent years had been the introduction of miniature enclosed arc-lamps taking a small current, of perhaps 1·2 amperes only. It had long been felt that there was a need of some having a candle-power intermediate between that of the carbon filament and the arc-lamp.

The Nernst lamp, it is true, did something to fill the gap, but its complexity was a disadvantage. Consequently there had arisen a rapid succession of small enclosed arc-lamps called by various fancy names the "Miniature," "Mignon," "Rignon," "Baby," "Lilliput," &c.

The Regina Arc-Lamp Co. claimed to have achieved an improvement in their Regina, Helia, and Reginula enclosed lamps, by securing a more complete exclusion of the air than had been previously found possible, coupled with a reduction in the diameter of the carbons used. It was claimed, for instance, that the Regina lamp consumes only 0·8 watts per mean hemispherical candle-power, and will last

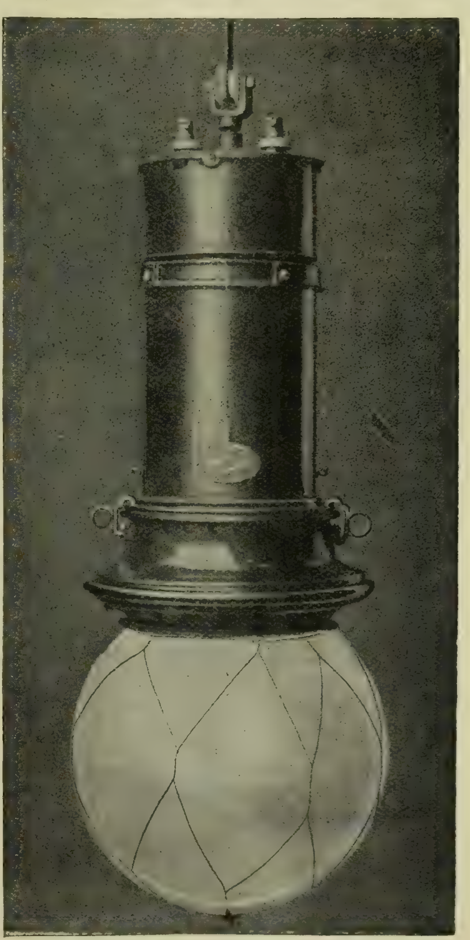


FIG. 5.—Oriflamme Arc-Lamp.

for 250 hours without recarboning. Some examples of these lamps were shown by Messrs. Marples, Leach & Co.

More recently still, however, a change in the situation had been brought about by the introduction of high candle-power tungsten lamps, which rivalled the most efficient enclosed arc in efficiency, and were without the

disadvantage of requiring occasional attention. The relative merits of both types of lamps had been recently discussed by H. Remanè (*E.T.Z.*, Aug. 20th, 1908).

USE OF LUMINESCENT GASES AND VAPOURS.

Mr. Gaster next proceeded to refer to vapour lamps which utilized mainly luminescent vapour and gases. The mercury lamp was a well-known illustration of this principle. By this means very efficient results were obtained, but the colour of the light was very peculiar. Many ingenious modifications of this lamp have been made, and the Westinghouse Co. had kindly exhibited a new type at the lecture, in which it was unnecessary to tip the lamp in order to start it, the starting being accomplished by breaking an inductive circuit, and thus applying a high instantaneous P.D. curve at its terminals.

Many attempts had also been made to improve the spectrum of the mercury lamp, but without any very practical success. This very peculiarity was, however, useful for certain special purposes.

Recently, however, an interesting advance had been made in Germany by Dr. Küch (*Verb. Deutsch. Elektrot.*, 1907). Hitherto if the pressure within the lamp were increased beyond a certain point, the increase in temperature caused the glass to melt, and therefore brought the lamp to a premature end.

Dr. Küch, however, constructed a tube of very refractory special quartz glass, which would stand a much higher temperature. It was then found that the efficiency increased as the power given to the lamp was increased, in accordance with the curve shown on the diagram.

The consumption per candle-power, after rising to a maximum, began to fall again, until eventually a value near 0·27 watts per mean hemispherical candle-power was said to be attained.

One interesting characteristic of the lamp was the fact that at the high temperature and pressure within the lamp luminescence was partially replaced by ordinary incandescence, and the line spectrum of mercury broadened out into a more or less contiuous one, with the result that the colour of the light was distinctly improved, and contained a certain amount of red rays.

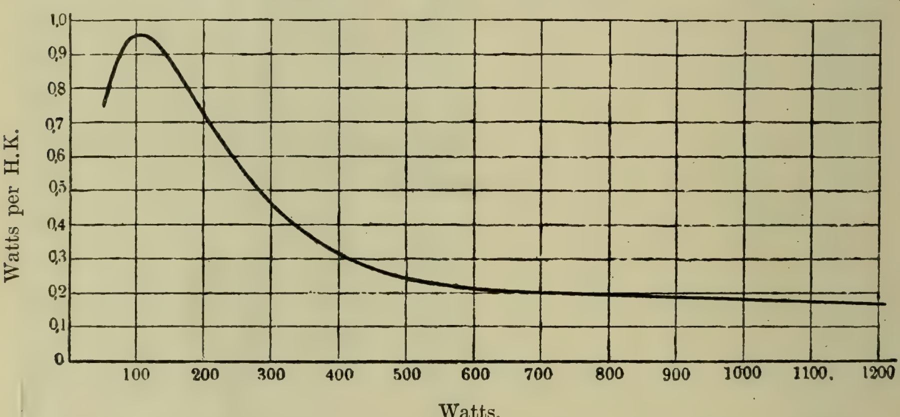


FIG. 6.—Showing Specific Consumption of Küch Lamp when Supplied with Different Amounts of Power.

Another striking peculiarity of the lamp arose from the fact that quartz glass allowed ultra - violet light to pass through. For ordinary purposes of illumination, it was necessary to screen the quartz tube with an absorbing glass envelope, which transmits the visible radiation, but largely absorbes the ultra-violet light.

In this connexion reference was made to the " Euphos " glass, designed by Drs. Schanz and Stockhausen, for the purpose of obstructing these rays, the lecturer remarking that this subject would be dealt with in greater detail in the last lecture. Several incandes-

cent lamp bulbs and chimneys made of this glass were exhibited.

Lamps of a similar character had been devised in Germany for purely photographic purposes, some of them such as the Heræus lamp, utilizing quartz glass, but others, like the Uviol lamp, which Messrs. Isenthal had kindly exhibited, having an envelope composed of a newly discovered glass which transmitted ultra-violet energy.

Finally, mention was made of the illuminant recently brought out in the United States by Mr. D. Macfarlane Moore.

It had, of course, long been known that gases could be made luminous when subjected to an electrical discharge in a highly-radified condition. To Tesla and others had occurred the idea of utilizing this effect in order to secure an efficient illuminant. It was, however, found that the condition of the gases within the tube quickly changed, partly owing to the absorption of gas by the electrodes, and means had, therefore, to be adopted to automatically control the condition of the gaseous contents of the tube. These devices, however, were for long unreliable.

To Mr. Moore belonged the credit of having very carefully studied the conditions and qualities of gases most favourable to the production of light, and the invention of an extremely ingenious form of valve, by the aid of which the pressure of the gas within the tube was maintained exactly constant.

The illuminant consisted of a long tube, which might be 30 or 40 ft. in length filled with suitable gases at a very low pressure, which were subjected to an electrical discharge at a high tension from a small electrical transformer. When a house was lighted by this system the tube ramified round the rooms up the staircase, &c., and, in fact, entirely replaced the ordinary wiring.

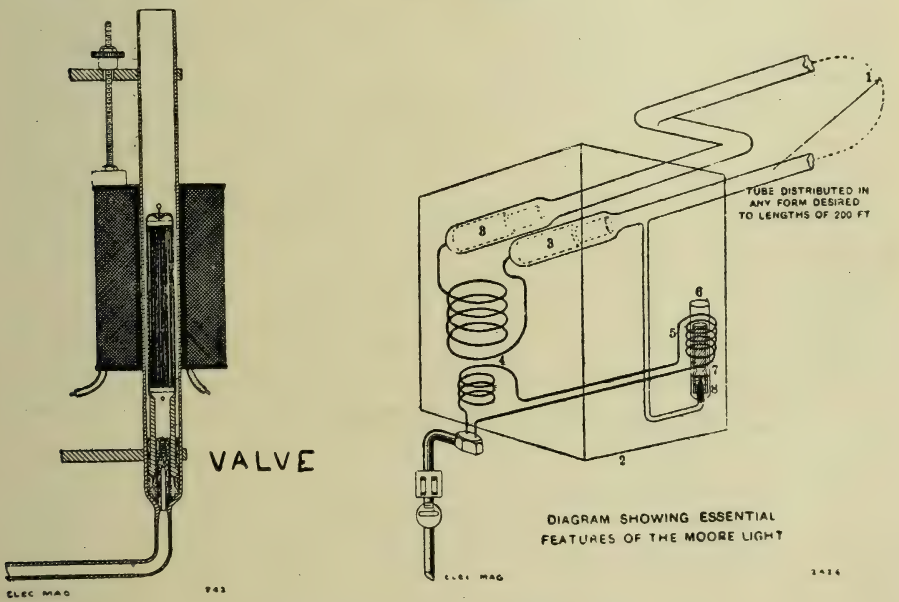


FIG. 7.—Essential Details of Moore Tube.

The consumption per candle-power of the tube varied according to the nature of the gas used in the tube, and likewise the colour of the light. Thus a tube filled with nitrogen yields light of a yellowish colour. But by using carbon-dioxideMr. Moore claimed to obtain a beautifully white light, which resembled daylight more closely than any other known illuminant.

In conclusion, Mr. Gaster described one conceivable method of lighting in the future, namely, by utilizing the principles of phosphorescence and fluorescence. By the latter term we

usually understand the degradation of ultra-violet into visible light energy, taking place only while stimulus was applied, while the word "phosphorescence" was used to describe an effect which continued afterwards. An experiment was then shown in which the fluorescent qualities of a few specimens of willemite, when acted on by the radiation from 5 milligrams irridium were exhibited. Thanks were due to Mr. A. C. Cossor for this apparatus.

There were not wanting illustrations of the practical use of these principles. For instance, it had been proposed to improve the spectrum of the mercury light by causing the ultra-violet energy to act on a phosphorescent substance, and produce red rays. Prof. S. P. Langley, who studied the phosphorescent light from fireflies, stated this to be the most efficient illuminant in existence, and the researches of Nichols and others, seemed to suggest that for some reason or other the radiation from phosphorescent materials almost invariably lay within the limits of the visible spectrum. It might be, therefore, that in the future we should secure our illumination by utilizing substances of this kind, which however were at present only in the experimental stage.

FIRST LECTURE.

Thanks are due to the following firms, who have kindly exhibited at the first Cantor Lecture.

Glow Lamps.

Metallic filaments mostly using tungsten as chief material.

Messrs. Boddy & Co.—Board equipped with latest types of "Metalik" filament lamps.

The Bryant Trading Syndicate.—Board equipped with metallic filament lamps, including the 16 candle-power 20-watt 100-volt type, and a show-case indicating details of manufacture and materials used.

British Thomson-Houston Co., Limited.—Exhibit of tungsten incandescent lamps.

The Edison & Swan United Electric Light Co., Limited.—Show-case containing different types and sizes of metallic filament lamps, including some in which the filament is mounted in an ordinary carbon glow-lamp bulb; also a carbon filament lamp of 1,000 candle-power, working at 100 volts.

The Electrical Co., Limited. — Board equipped with "Aegma" metallic filament and a high candle-power; 200-volts Nernst lamps using 3 burners giving out 1,000 candle-power.

Messrs. Falk & Stadelmann, Ltd.—Exhibit of several "Sirius-Effesca" metallic filament lamps.

The General Electric Co., Ltd.—Board equipped with Osram lamps, including the tubular reflecting type; and a 400 candle-power lamp, mounted on a fixture used for inverted illumination.

Stearn Electric Co., Limited.—Exhibit of Stearn "Leuconium" type of metallic filament lamps, burning several in series.

Sunbeam Co., Limited. — Exhibit of metallic filament lamps.

The "Z" Electrical Syndicate. — A showcase containing the different types and sizes of metallic filament lamps.

Messrs. Siemens Bros., Ltd.—A board showing the latest designs of tantalum lamps and cluster of different designs using holophane globes and reflectors.

Messrs. Julius Sax & Co., Ltd.—Metallic filament lamps in connexion with holophane glassware; installed one big holophane sphere for lighting up the main staircase of the Society.

Arc-Lamps and Mercury Vapour Lamps.

Messrs. Crompton & Co., Limited.—Two Crompton-Blondel Arc-lamps.

The Jandus Arc-Lamp Co., Limited.—Examples of Jandus enclosed and Jandus regenerative flame arc-lamps.

Marples, Leach & Co., Ltd.—Examples of Regina, Helia, and Reginula arc-lamps, and special photographic arc-lamps.

The Oliver Arc-Lamp Co., Ltd.—The Oriflame alternating current arc-lamp and magazine type.

The Union Electric Co., Limited.—Duplex excello arc-lamps, provided with new prismatic inner globe, and special ventilation arrangement; alternating current arc-lamp and "Kohinoor" type lamps.

The Westinghouse Co., Limited.—Mercury-vapour lamps of Cooper-Hewitt type, including the new "Static" type, by which instantaneous ignition is obtained without tilting the tube.

Mr. A. C. Cossor. — Specimens of fluorescent and phorescent materials excited by 5 milligrams of radium, and other apparatus.

Messrs. Isenthal & Co.—The "Uviol" mercury-vapour lamp.

[All these were in operation after the lecture.]

We propose to deal with Lectures II., III., IV., in subsequent numbers of *The Illuminating Engineer.*

The Art of Shading.

By John Darch, F.S.I., Mem.R.San.Inst.

(*Continued from p.* 86.)

Fortunately for the art of shading, the ordinary man is not likely to occupy every cubic foot of space in the apartments to which he resorts, as would a bird in an aviary or a fish in an aquarium, but is usually limited to an occupation level; while in such places as a church or a concert-room his position and the direction of his gaze are still further restricted, affording greater possibilities in shading and illumination. Let us take, for illustration, the more common case of a drawing-room, 20 ft. × 16 ft. × 11 ft. high. Such a room would contain 3,500 cubic feet. The level of the eye in standing would seldom exceed 5 ft. 6 in. from the floor, nor in sitting be less than 3 ft. 6 in. The perambulation of the eye is, therefore, confined to a central space within the room of about 380 cubic feet, indicated by the shaded space in Fig. 5, leaving 3,120 cubic feet out of 3,500, which should be quite free to the passage of direct light. Let us assume that the room is lit by four or six 16 candle-power brackets, 6 ft. 6 in. from floor; brackets are not necessarily the best means of lighting, but they are there. The ceilings and walls should be of a light tint, the ceilings particularly. The size and form of the shades may be ascertained, as shown in Fig. 5. Draw a line, AB, from the top of the light A to the position of the eye in standing at the farther end of the room, and another, AC, from the bottom of the same light to the nearest usual position of the eye to the light when in sitting posture. The shade D will be required to cover the angle BAC. The other lights in the room to be treated in the same manner. The horizontal form of the shade may be found by drawing lines laterally from the inside of the light to the nearest ordinary position of the eye to the wall, taking furniture or other obstructions into consideration. The result will be somewhat as shown in Fig. 6, where A represents the shade on a flat wall, and is semicircular; B assumes a quadrant form, and C an obtuse angle. If the splayed wall CD be

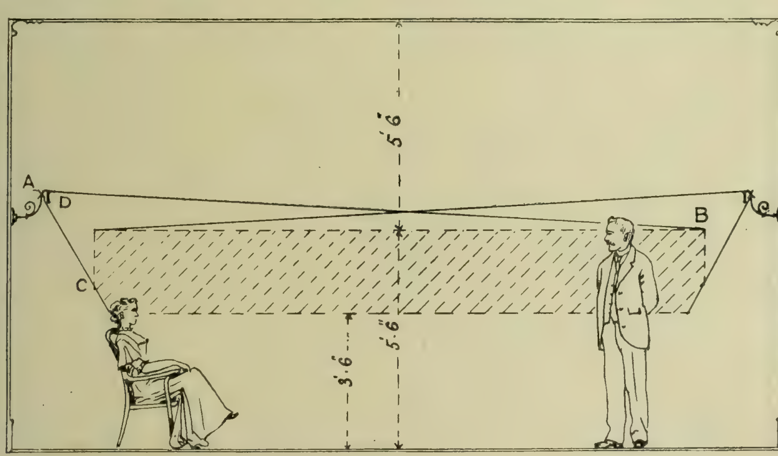


Fig. 5.

covered with a mirror, as to an angle chimney breast, then an adjoining shade would have to be a semi-circle to cover reflection, as shown in dotted lines. Mirror backs should not be used to lights. In practice these shades average 2½ inches in vertical width, and seven inches diameter across the

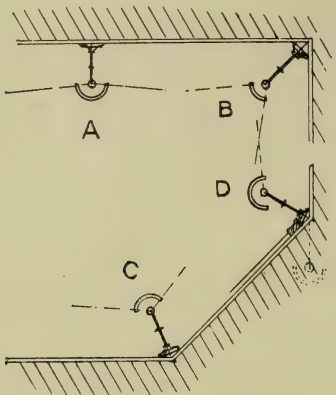


FIG. 6.—Plans of Shades.

semi-circle when applied to living rooms. An example is shown in Fig. 7, which consists of a wire frame lined inside with white silk, and covered with pleated white or coloured silk to the necessary degree of semi-opacity. Porcelain, tortoiseshell, or any other material may be used that will not yield a surface brightness exceeding ·05 candle-power per square inch. The more fireproof the material the closer it may be fixed, and therefore

FIG. 7.—Silk Shades.

the smaller the shade may be. The interior surfaces should always be white. Intervening glass is unnecessary and wasteful.

The chandelier is a class of fitting that has received more patronage than it deserves, but assuming that one has to be shaded—or a pendant for that matter—the same principles will apply; but it must be borne in mind that a bracket would be viewed from one side only, a pendant all round. The shade must, therefore, be a narrow ring. In all and every case it is desirable to keep the shades as narrow and as low as the complete hiding of the light will permit. The lines AB, Fig. 10, should be 30 degrees from the vertical.

A frieze of lights may be arranged, as in Fig. 8, AB being the frieze, opaque or semi-opaque, supported on light metal or other brackets, which also carry the row of lights. The advantage of this arrangement over that of hiding the light behind a cornice is that while the eyes are equally shielded, the walls and room are more evenly illuminated.

In the foregoing examples the surfaces of the shades are made vertical, as this best meets the requirements

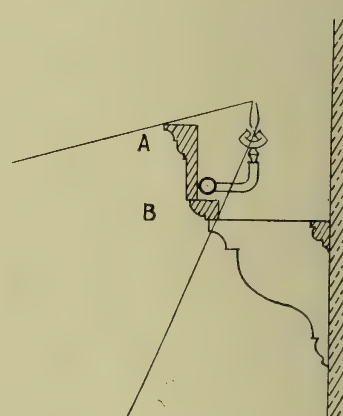


FIG. 8.—Frieze Lights.

for general lighting from the usual positions of lights; but in some cases it may be advantageous to have them conical—normal or inverted—when that form affords better protection to the eyes, and aids the fuller illumination of the room. (See Figs. 9 and 10.)

Where arc lamps or clustered lights are used in the ceilings of public halls or business-places no shading should be required if the lights are high enough or otherwise out of range of vision; they are, however, frequently placed on low ceilings when they become obtrusive and troublesome. In such cases an easy remedy would be found in the ring shade suggested in Fig. 10.

The shading, as suggested, is applicable to existing lighting, whether brackets, pendants, or standards. How easily the annoyance arising from obtrusive platform, pulpit, or other lights in church or concert-room could

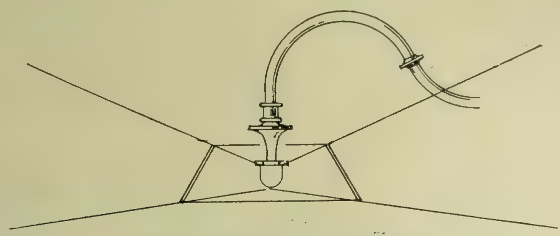


FIG. 9.—Shade for Low Lights.

be prevented by the simple application of shades at the rear of the lights without materially diminishing the general illumination ! Moreover, it would certainly improve the general visibility and general effect. In most cases all that would be required could be provided by the use of

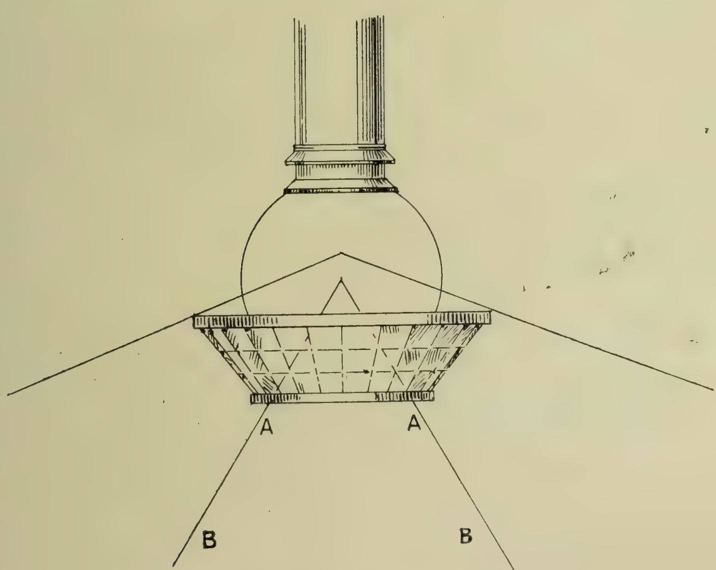


FIG. 10.—Shade for High Lights.

quadrant-shaped, opaque, or semi-opaque shades to the wall-brackets, and similar but semi-circular shades to the pendants and standards, used in the manner already indicated.

It is not intended that this form of shade be employed under all circumstances or supersede a skilful arrangement of lights, which is far better. Few buildings, however, can be wholly and satisfactorily lit without effective shading or the pernicious alternative of visible lights ; as much lighting as possible should, however, be done without it, or by placing the lights so that the ordinary features of the building form sufficient screen.

The new hall of the Glasgow Engineers and Shipbuilders is noticed in a recent number of a contemporary, and, amongst other features, the lighting of the hall, which appears to have been carried out under the direction of a special committee of the Institute,

consists of lights set in two rows of pendant troughs. (See Fig. 11.) The screening of the light is excellent, but it is difficult to understand why it should be necessary to obscure the upper half of the room with a becoming ceiling, and to deprive themselves of the reflected light from such a large surface.

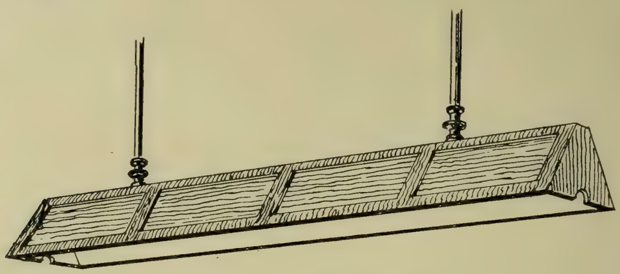


FIG. 11.—Trough Lights.

In an article on church lighting in *The Electrical World* of October 6th, 1906, Messrs. Cravath and Lansingh describe a novel and excellent form of shade to lights that are to be brought down to near the reading level. The sketch in Fig. 12 is made from some

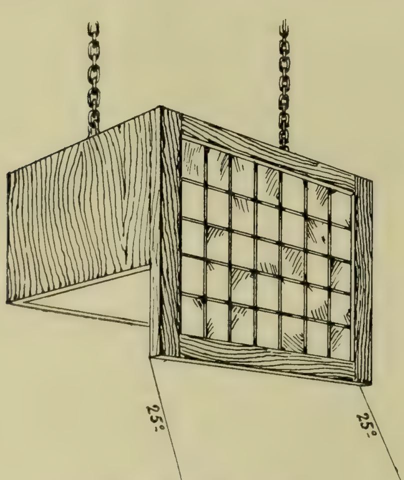


FIG. 12.—Box Shade.

plans, and sections of it given in the journal. It is really a box closed on all sides but the bottom, the rear—and sides also if desired—being filled in with what is described as art glass of a dense character. There are some variations on this form. The body of the box is about 2 ft. 9 in. × 2 ft. × 1 ft. 3 in. high. The rear side extends downwards a further 9 in., but the exact distance is governed by the position of the light, which should make an angle of 25 degrees therewith. These shaded lights could only be used as supplements to the general lighting.

The art of shading is most happy in its development when it applies itself to the utilization of the architectural and constructive features of a building with the deft and unobtrusive additions of narrow margins, fillets, and any other device that will aid the shading and perfect illumination of the building. These additions should be considered at least as legitimate as the expensive and view-obstructing chandeliers that cumber our great and historical buildings, sacred and secular. The chancel arch of a church will usually cover enough lights to illuminate the chancel beautifully; if not, then shade. The canopy of a pulpit could easily contain two or three lamps, and the preacher's face and book be illuminated satisfactorily to himself and his audience. A shop front offers no difficulty both to cheap and satisfactory illumination; and so on, to the most difficult of all, street-lighting, in which shades may advantageously be employed.

If the architect would devote the same forethought to the lighting of his buildings as he does to the fireplaces and other essential provisions for ultimate occupation, success would be half assured; as it is, this important matter is usually an after consideration, and the illuminating engineer is called in when it is too late to make satisfactory provision.

A Study on the Economical Possibilities of Lighting by Means of Carbon Filament Lamps.

By An Engineering Correspondent.

(*Continued from p. 108.*)

For 200 volts 16 candle-power lamps the equation expressing useful life reads as follows :—

$$L = W^4 \times K$$

where $K = 1{\cdot}25$.

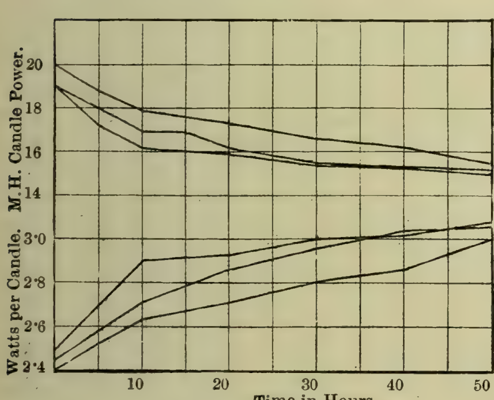


Fig. 10.—Candle-Power and Efficiency Test of three 200-volt Lamps run at Average Efficiency of 2·8 Watts per Candle.

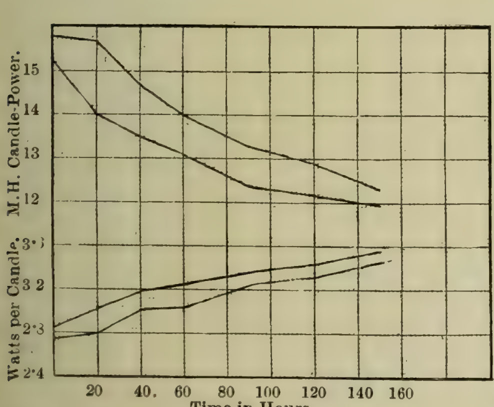


Fig. 11.—Candle-Power and Efficiency Test of two 100-volt Lamps run at Average Efficiency of 3·1 Watts per Candle.

TABLE XI.

Life and Efficiency of 200 Volt 16 Candle-power Lamps, ranging from 3·8 to 5·25 Watts per Candle.

Average Watts per Candle.	Useful Life.
3·8	270
4·4	500
4·6	600
5·25	1000

In Fig. 11 a curve is plotted from the values obtained from the above formula for 200 volt lamps, the actual test-values being shown by a cross. One now has the means of readily estimating the cost of lighting, using carbon filament lamps of various efficiencies.

From the curve in Fig. 8 it is possible to estimate the number of candle-hours obtainable from a 100 volt 16 candle-power lamp of high or low efficiency, and further, to determine the cost of lamp renewals per candle-hour when the price of the lamp is known.

In Fig. 13 the thin line curve at the bottom of the diagram shows the cost of lamp renewals in pence per kilo-candle hour at different values of average watts per candle. This curve is calculated from the results in Fig. 8, the cost of lamp renewals being taken as 10*d.* each.

The straight lines in Fig. 13 show the cost per kilo-candle-hour for energy at prices of current ranging from 1*d.* to 7*d.* per unit. The thick line curves show the total lighting cost, being obtained by the addition of the fixed charges and the energy charges; the latter, of course, varies according to the price of current per unit. All these

curves have a minimum occurring on a certain value of watts per candle, a deviation from which, in either direction, entails an increase in the lighting cost. This increase occurs at a much higher rate for lighting costs where the price of current is high, where a slight change in the efficiency of the lamps causes an appreciable alteration in the lighting costs. The majority of 16 candle-power 100 volt lamps in use at the present time are rated at $3\frac{1}{2}$ watts per candle, the average efficiency obtained being about 3.9 watts.

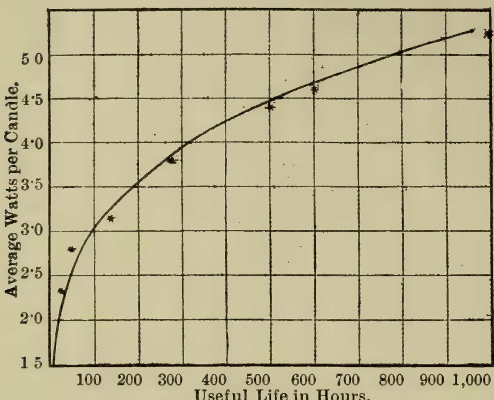


FIG. 12.—Curve showing Useful Life of 200-volt 16 Candle-Power Lamps, in Terms, of the Average Efficiency in Watts per Candle.

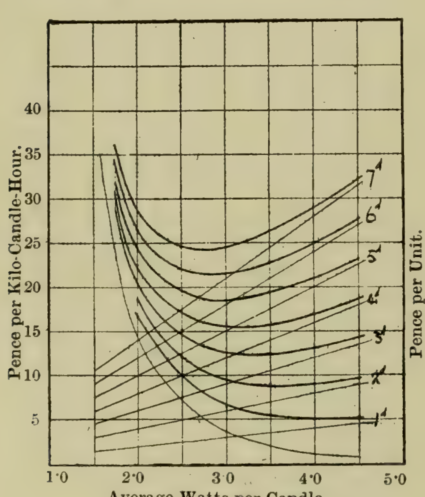


FIG. 13.—Total Cost of Electric Lighting in Pence per Kilo-Candle-Hour at Different Prices of Current, using 100-volt 16 Candle-Power Lamps of various Efficiencies.

When such a lamp is used on a supply at 7*d.* per unit the cost of light will be 29 pence per kilo-candle-hour, whereas if a lamp rated at $2\frac{1}{2}$ watts be employed the cost will be reduced to 24*d.*, thus effecting a reduction in cost of 17 per cent. Where current is obtained at 4*d.* per unit a 3 watt lamp could be profitably employed, the reduction in cost being from 27 to 25·5 pence per K.C.H., with a saving of 5·5 per cent.

At 1*d.* per unit no great change occurs in the lighting cost from $3\frac{1}{2}$ to 5 watts per candle, the lowest point of the curve occurring at an efficiency of 4·25.

A similar set of curves are shown for 200 volt 16 candle-power lamps in Fig. 14. The renewal costs in curve A are much higher than for the 100 volt lamps at corresponding efficiencies, this being partly due to the shorter useful life obtained, and also to the higher price of lamps, the price being taken at 12*d.* each.

It is the practice of lamp manufacturers to rate the 200 volt lamps at $\frac{1}{2}$ watt higher efficiency, the 16 candle-power lamps being rated at 4 watts per candle. Assuming the average efficiency to be 4·4 watts per candle, then the cost per K.C.H. at 7*d.* per unit is 32·5 pence, while the minimum cost at 3·4 watts falls to 28·5 pence, a saving of 12·3 per cent. At 4*d.* per unit the lighting cost can be reduced from 19·5 to 18*d.* per kilo-candle hour. At 1*d.* per unit the lighting cost varies but very slightly between 4 and 5 average watts per candle, enabling any lamp of ordinary efficiency to be used with equal results.

From the curves in Figs. 13 and 14 it is evident that the efficiency of the lamp to be employed should be chosen according to the price of current, whereas it is the practice to use lamps of the same efficiency for all electric lighting installations, irrespective of the cost of energy.

Fig. 15 shows the desirable efficiency to employ, to obtain the most economical results, at different prices of current per unit. It should be noted that the mean efficiency throughout useful life is given, and to obtain the corresponding initial watts per candle, which it is customary to express in

rating glow-lamps, an allowance of 10 per cent should be made. The cost of current to different classes of consumers varies between the following limits :—

(*a*) Consumers with large isolated plant, 1*d*.–3*d*. per unit.

(*b*) Shops and business lighting, 3*d*.–5*d*. per unit.

(*c*) Private house lighting, 5*d*.–7*d*. per unit.

For property owners who have lighting plant installed, the price per unit should be estimated on the fuel consumption only, as in many generating stations the cost for fuel does not exceed ½*d*. per unit, and in such cases it is preferable to use lamps of low efficiency and long life. It would hardly be practicable for glow-lamp makers to supply lamps suitable for obtaining minimum costs at all prices of current per unit; therefore it is recommended that lamps be supplied at three ratings, for 100 and 200 volts respectively, suitable for use with circuits *a*, *b*, and *c*.

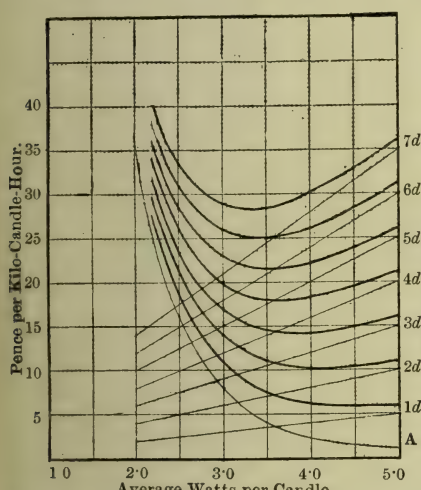


FIG. 14.—Total Cost of Electric Lighting in Pence per Kilo-Candle-Hour at different Prices of Current, using 200-volt 16 Candle-Power Lamps of various Efficiencies.

	100 volt.	200 volt.
(a) 1^d – 3^d	3·5 initial watts per candle	4·0 ,,
(b) 3^d – 5^d	3·0 ,, ,, ,, ,,	3·5 ,,
(c) 5^d – 7^d	2·5 ,, ,, ,, ,,	2·5 ,,

It would be futile to attempt the graduation of lamp efficiencies for commercial purposes to a greater extent than this, *i.e.*, by smaller succeeding increases in efficiency than one half watt per candle, as lamps frequently show when tested values varying 7 or 8 per cent above or below the specified watts per candle. It is important to notice the difference in the cost between 100 volt and 200 volt lighting; at all prices of current a saving of 14 per cent in favour of 100 volt lighting is shown by comparison from Figs. 13 and 14.

There are, in addition, further advantages for 100 volt supply, namely, reduced risks from electric shock, and superiority for arc lighting purposes,

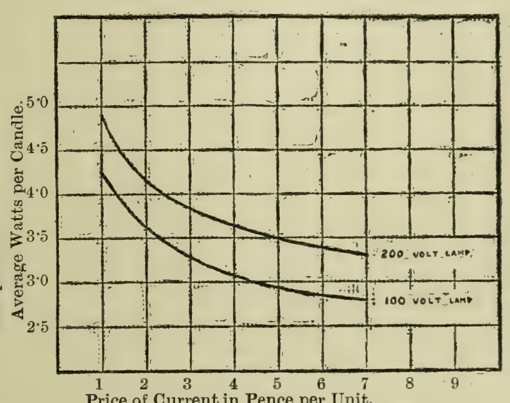


FIG. 15.—Curves showing Desirable Efficiency to employ at various Prices of Current per Unit in order to obtain the most economical Results.

and it should be carefully considered when designing a lighting installation, whether the saving in copper will justify the adoption of a 200 volt pressure.

It will be obvious, from conclusions based on the investigations of this article, that in many places where the carbon glow-lamp is employed, full advantage is not being taken of its economical possibilities. This state of affairs has partly been established by the lamp manufacturers, who in their anxiety to supply lamps having a long life, have kept the efficiency low in order to accomplish this, although it would be to their advantage to sell lamps of higher efficiency, in consequence of the increased renewals.

On the other hand there is a noticeable reluctance on the part of the con-

sumer to expend more than is absolutely necessary on lamp renewals, in many cases old lamps being burnt for hours after the period of useful life is reached.

In buildings where the lighting arrangements are in charge of a resident engineer, or under the supervision of a Consulting Engineer, even where it is necessary to employ carbon lamps, substantial reductions can be made in the lighting bill by a careful selection of lamps to suit the existing conditions of supply. Contractors could also advise their clients, regarding the correct rating of their lamps, as determined by the price of current in each case, although in many instances the metallic filament lamp will give the more economical results. However, the purpose of this article was to indicate how economies might be effected in electric lighting where it was expedient to use the carbon filament lamp, and the writer has, therefore, refrained from making comparisons with the metallic filament lamp. E. G. K.

Lamps for Motor Cabs.

In our February number (p. 125) we mentioned an instance, quoted in a letter to *The Daily Mail*, of the need for some more adequate method of illuminating the taximeter dial by night, so that the passenger can read his fare, without being put to the inconvenience of striking matches.

We now note that, according to the paper named above, the General Motor Cab Company are making arrangements to rectify this omission. Within a few weeks they will, in accordance with a recent police order, provide all cabs with a lamp which will illuminate the face of the taximeter.

This lamp will also fulfil a second object. It is to be placed midway between the two front windows, and will be equipped with blue glass in front so as to show a blue light when the cab is disengaged. Intending passengers will thus have an opportunity of ascertaining at once whether an approaching cab is disengaged. Without some such arrangement it is quite possible that the cab may pass them before they realize that it is vacant.

As soon as the cab is hired, however, the driver, before setting the taximeter in in motion, will turn down an opaque disc so as to obscure the blue light, and thus indicate that his vehicle is engaged.

Tests of 220-Volt Metallic Filament Lamps.

A recent number of the *Zeitschrift für Beleuchtungswesen* contains the results of some experiments, carried out in the laboratory of Dr. H. Lux, upon 220–250 volt metallic filament lamps.

These lamps, it is stated, were bought in the open market, and therefore represent goods as actually used and manufactured. While it is interesting to observe that so many companies are manufacturing metallic filament lamps for high pressures, it will be observed that the efficiencies of the lamps seemed to vary very considerably. At least two lamps of each make were tested.

Experiments on the temperature and radiant efficiency of these lamps are still being carried out.

Make of Lamp.	P.D.	C. P. (Hefner).	Watts per H. K.
Siemens & Halske Tantalum	220	80·8	1·90
	220	79·2	1·76
Hollefreund & Co., Zirkon	220	39·0	1·52
	220	38·1	1·54
A. E. G.	220	39·0	1·41
	220	36·7	1·50
Bergmann, A. G.	220	48·5	1·40
	220	48·5	1·36
Sirius-Colloid	220	42·5	1·27
	220	44·0	1·25
Felten-Guilleaune Lahmeyer	220	35·5	1·64
	220	35·4	1·63
Deutsch. Gasglüh. Ges. Osram.	220	44·5	1·29
	220	44·5	1·29
	220	42·2	1·35
	225	45·4	1·28
Lichtwerke G.m.C.H. Sonnenlampe.	220	62·5	0·88
	220	68·2	1·11
	220	67·0	1·10

The Bristol Lighting Curve.

By J. B. Clarke.

The system of public lighting in the principal thoroughfares of Bristol being by electric arc lamps, centrally controlled from the Temple Back Sub-Station in the heart of the city, affords an opportunity of recording the times of lighting and extinguishing lamps with precision; the controlling feature being the daily atmospheric conditions, which are taken into consideration and regulate the times of switching the lamps on and off—the weather influencing a variation as great as twenty minutes from one day to another; the operation being performed at the last vestige of disappearing daylight in the evening and the first glimmer of natural light in the mornings.

The evidence of careful management at Bristol is in striking contrast with a certain town on the south coast, where public arc lamps have been observed lighted in the full glare of the morning sun, being extinguished quite an hour after sunrise.

The "waist" diagram, or curve, produced on the opposite page, shows the average time of public arc lighting compared with the period of darkness between the setting and rising of the sun at Bristol—the time at Bristol being later than at Greenwich by 10½ minutes. It will be noticed that the twilight or unlighted period in June is practically twice that of December; while the maximum and minimum period between the setting and rising of the sun is 16·33 hours in winter and 7·66 hours in summer, the maximum and minimum artificial outdoor lighting being 15·33 hours in winter and 5·66 hours in summer.

TABLE I.

Hours of Public Lighting. Bristol, 1907–1908.

Month.	No. of Days.	Hours to Midnight.	Hours after Midnight.	Total Hours' Lighting.	Average Hours' Lighting per Day
March	6	30·1	32·65	62·75	10·46
April	30	132·566	144·15	276·716	9·22
May	31	108·067	113·283	221·350	7·13
June	30	86·234	90·15	176·384	5·87
July...	31	94·283	104·81	199·093	6·42
August	31	121·383	126·05	247·433	7·98
September...	30	149·883	153·483	303·366	10·11
October	31	191·367	186·0	377·367	12·17
November	30	214·38	209·66	424·04	14·13
December	31	230·99	238·66	469·65	15·15
January	31	219·65	238·58	458·233	14·78
February	29	179·5	202·58	382·08	13·17
March	25	137·32	153·566	290·886	11·63
	366	1895·723	1993·622	3889·348	10·627

In Table I. is given the hours of lighting for Bristol, 1907–8, wherein is recorded 3889·348 hours of artificial lighting as compared with 4316·699 hours of darkness between sunset and sunrise, making an unlighted period of 427·351 hours in 366 days.

In a large city such as Bristol this unlighted period is of considerable importance, for the saving, when estimating the public lighting charge based on atmospheric conditions in

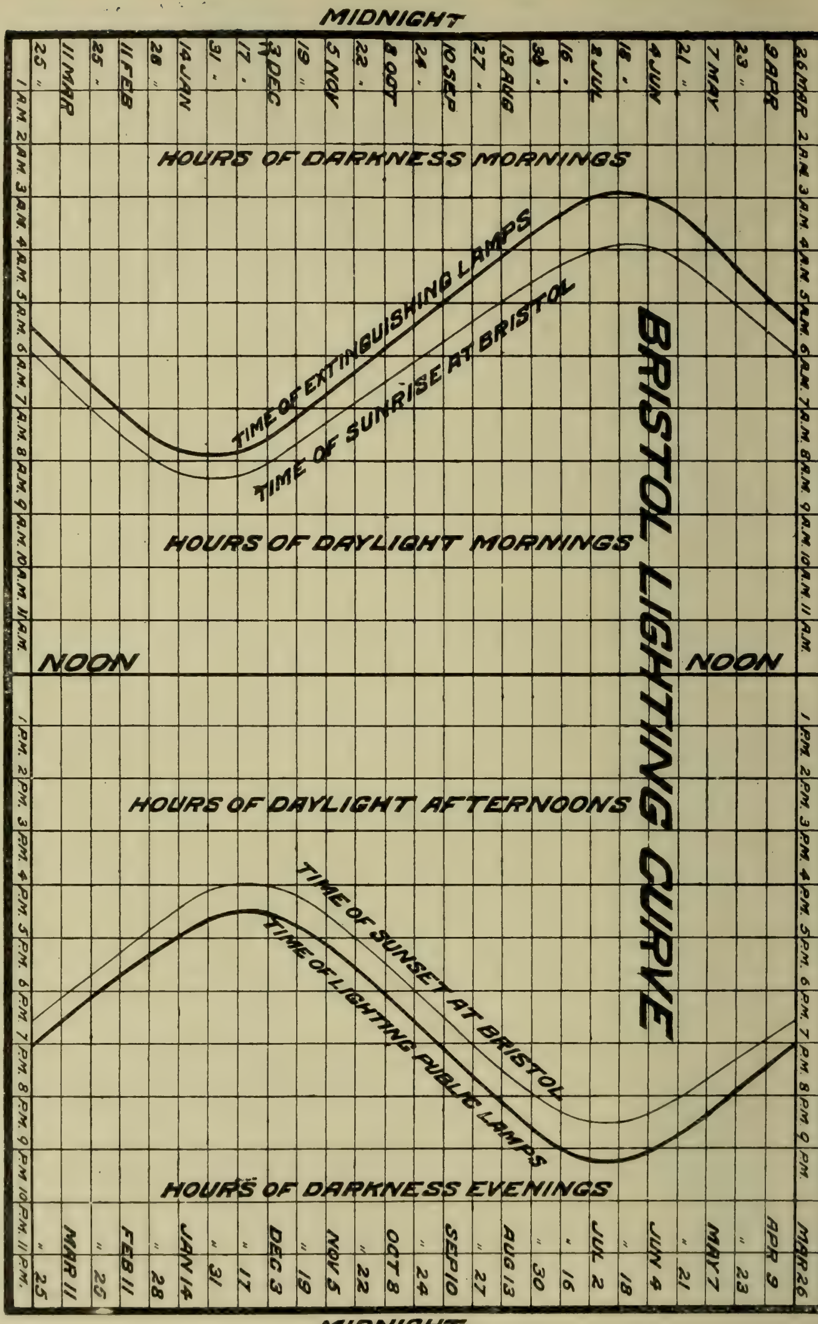


Fig. 1.—Average time of public arc lighting in Bristol compared with the period of darkness between sunset and sunrise in this locality.

preference to the times of sunset and sunrise, is obvious; for, assuming the electricity required by 400 arc lamps, taking 500 watts per lamp, in use morning and evening, we find the saving to be over 85,400 units per annum.

In using a table of sunrise and sunset as a basis from which to estimate the time of artificial lighting before and after midnight, it must be remembered tha the figures published in the 'Nautical Almanac,' 'Whitaker's,' &c., refer to the meridian of Greenwich, and are only applicable to other places by making due allowance for the local time being before or after Greenwich mean time at the place in question.

For example, throughout the year (leap year) there are 2158·33 hours from sunset to midnight, and 2158·366 hours from midnight to sunrise at the meridian of Greenwich; but at Falmouth during the same period there are 2033·33 hours from sunset to midnight, and 2283·366 hours from midnight to sunrise; showing that a town in the West of England can have in use lamps from sunset to midnight at a less cost than the same can be in use in an eastern town such as Lowestoft, where the evening darkness exceeds the morning darkness. On the other hand, in Dublin, although the local time is 25 minutes after English time, the morning and evening darkness are the same as at Greenwich; this is brought about by the fact that Irish time is 25 minutes after English time.

Table II. gives the approximate variation which it is necessary to allow from the published times of sunrise and sunset; also the number of hours' darkness in the mornings, and evenings, which it will be observed differ in various places.

Twice in the year, at the Vernal and Autumnal Equinotes, sunrise and sunset, at places having the same local time but in different latitudes, is identical. At the Summer Solstice the length of day increases with latitude, at the Winter Solstice the higher the latitude the shorter the day. Consequently at Midsummer the sun rises about twenty minutes earlier and sets twenty minutes later at Edinburgh than at Cardiff. At Midwinter the reverse is the case.

TABLE II.

Town.	Minutes' Variation from Published Tables of Sunset and Sunrise.			Darkness.	
				No. of Hours Midnight to Sunrise. Mornings.	No. of Hours from Sunset to Midnight Evenings.
Lowestoft ...	7	minutes	before	2115·6	2201
Norwich ..	5	,,	,,	2127·9	2188·7
Maidstone ..	2	,,	,,	2146·1	2170·5
Boston... ...	0	,,	,,	2158·3	2158·3
Lincoln ..	2	,,	after	2170·5	2146·1
Portsmouth	4½	,,	,,	2185·7	2130·9
Rugby... ...	5½	,,	,,	2191·8	2124·8
Bradford ...	7	,,	,,	2201	2115·6
Glasgow ..	17	,,	,,	2262	2054·6
Falmouth ...	20½	,,	,,	2283·3	2033·3
Manchester	9	,,	,,	2213·1	2103·5
Liverpool ...	12	,,	,,	2231·5	2085·1
Swansea ...	15	,,	,,	2249·8	2066·8
Greenwich		**0**		**2158·3**	**2158·3**

The column "minutes variation" in Table II. is the average Winter and Summer.

Street-Lighting Improvement Club.

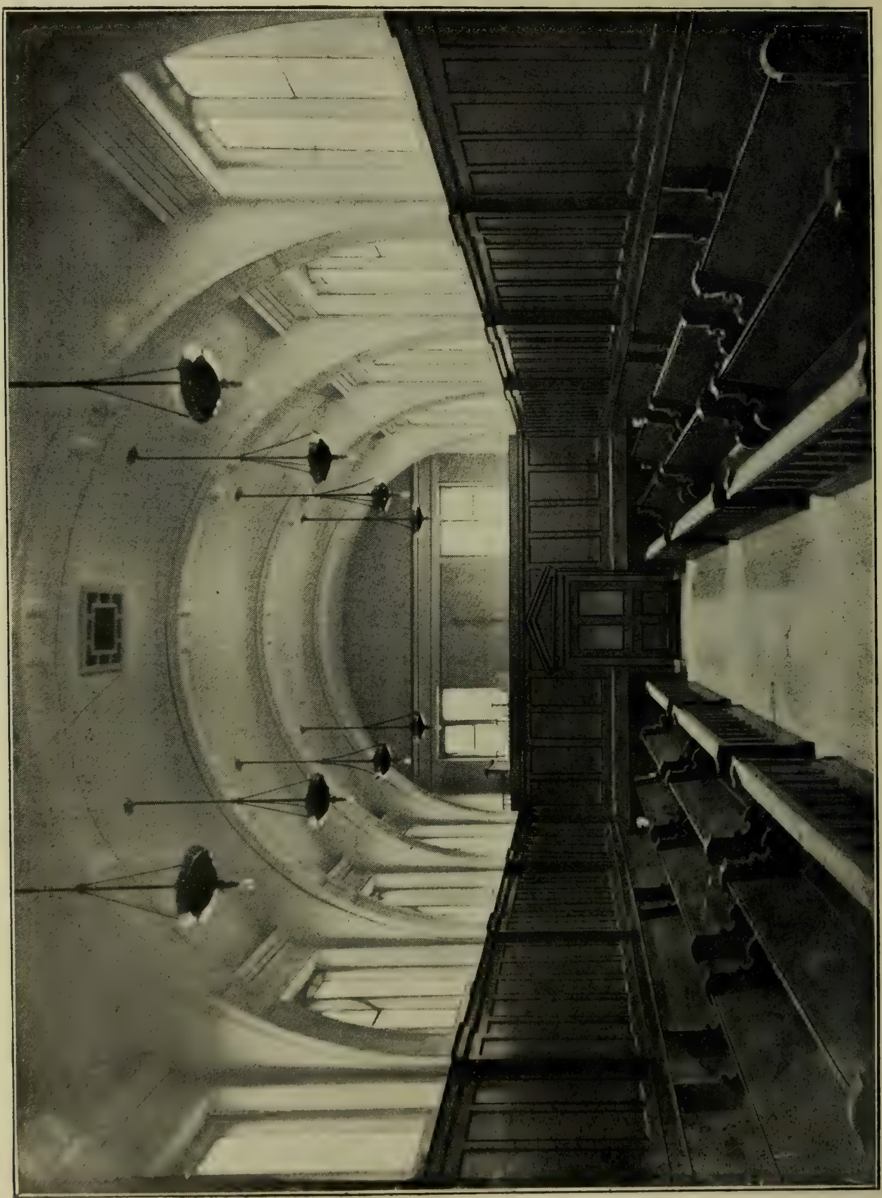
A RECENT number of *The Electrical Review* of New York refers to an interesting and enterprising effort of a club in West Aurora, Ill., organized for the purpose of improving the business section of the city. To this end the club has installed a series of 72 iron posts, carrying in all 226 tungsten lamps. This installation was formally presented by the Club to the city of West Aurora, and, we are informed, when the lamps were switched on, "the greatest satisfaction was manifested."

Inverted Lighting by Means of Osram Lamps.

By an Engineering Correspondent.

It has several times been pointed out recently that the high efficiency of the newer illuminants is of special value, because it enables us to bear without flinching the sacrifice of a certain amount of light involved in the use of adequate diffusing apparatus.

Much stress has often been laid upon the economy in power that can be achieved by the introduction of metallic filament lamps; but it is, at least, equally worth recognition



Inverted Lighting of Chapel, Royal Infirmary, Manchester.

that we can now often afford to be content with a relatively small economy in this direction in order to obtain our light in a more convenient form. We can afford to soften and diffuse our light by the use of suitable shades and reflectors in a more liberal fashion than hitherto.

An interesting result of the development of metallic filament lamps has been the application of the electric glow-lamp to inverted lighting, a field in electric illumination hitherto almost exclusively occupied by arc-lamps. A system of inverted lighting by Osram lamps has, for instance, been adopted in the Inns of Court Hotel, Holborn.

Another illustration of the method is to be seen in the accompanying view of the chapel in the Manchester Royal Infirmary, for the use of which acknowledgment must be made of the courtesy of *The Electrical Field.*

The lighting is accomplished by ten bronze dishes, the interior portion of which is enamelled so as to secure a satisfactory reflecting surface, the pendant being fitted with five Osram lamps ; a single lamp is also attached to the underside of each fitting to act as a pilot.

The results are said to be pleasing, and the use of inverted fixtures of this description certainly has the great advantage of completely screening the sources themselves to the eye. In an infirmary the avoidance of anything calculated to distress the eye is, needless to say, specially necessary. In addition the method seems to deserve commendation in such cases as the above, in which a uniform bright illumination over all the benches is, presumably, required in order that those present can read with comfort.

On the other hand, a ceiling that is not only white initially, but can be maintained so, is essential to the success of the method, and it is conceivable that in many chapels of great architectural value the use of such a uniform and shadowless illumination would be deemed undesirable on æsthetic grounds.

Good Illumination and Accidents.

An interesting instance of the connexion of bad illumination with accidents was described in a recent number of the *Westminster Gazette* (February 15th, 1909). An inquest was recently held into the death of Mrs. Mary Allen, aged sixty-six, who tripped and fell when passing out of the Queen's Hall. In the evidence it was stated that the lights in the Hall were lowered directly the performance was over, and that this might have led her to stumble, though it was also stated that this was the first accident that had occurred in this way.

After returning their verdict the jury added a rider that no negligence was attributable to any of the attendants, but recommended that no lights should be lowered in the Hall in future until the whole of the audience had left the building.

Ideal Relations between the Central Station and the Contractor.

A RECENT article by Mr. George Lewis in *The Canadian Engineer* presents a wise view of the necessity for co-operation between the central station and the contractor. The writer points out that both are concerned with the utilization of electricity to the best advantage, and especially advocates that the consumer should be advised, not so much to endeavour to reduce his bill, as to utilize more light.

"The customer," he says, "is not so much concerned about the amount of the lighting bills as the quality and quantity of the illumination he is getting for the money expended."

Co-operation between the suppliers of electricity and the contractor, in order to emphasize this point, would do much to eliminate the present friction, and to enable both to work together for their common benefit.

Further Notes on the Exhibits at the Berlin Exhibition of Shipbuilding and Naval Architecture.

With special reference to the illumination of Beacons, Lighthouses, &c.

By W. Biegon von Czudnochowski.

The security of navigation at the present day is intimately bound up with our systems of illuminating channels, and giving information of the whereabouts of rocks, shallows, sandbanks, &c. The complexity of our arrangements for this purpose have notably increased of late years, not only because of the progress in existing methods of illumination, &c., but also because the greater draught of modern ships, and the increased speed at which they now travel, demands more perfect arrangements, and a greater intensity of light than would, perhaps, have been considered adequate twenty years ago.

Naturally, therefore, the exhibition of apparatus connected with lighthouses, &c., formed an important item in the exhibits at the recent exhibition of shipbuilding in Berlin.

I.—Development in Sources of Light.

In olden times the only material available for illuminating lamps in lighthouses was oil. Burners were originally on the Argand concentric wick principle. Afterwards gas lights came into use, the beacon at Salvore, near Trieste (1818), being one of the earliest examples. In 1819 parabolic mirrors were introduced at Neufahrwasser, near Dantzig. Subsequently petrol and acetylene came to be used. But the end of the nineteenth century brought a new variety of light into general use, namely incandescent mantles, fed either by gas, petrol-air, or acetylene. Apart from the electric arc-light, these systems represent the most intense lighting effects available.

Petrol incandescent lamps, now well known, are fed by compressed air passing over a petrol vapourizer and automatically controlled: originally the arrangement had to be started by the aid of two small subsidiary spirit lamps, which were removed when a steady condition of the lamp ensued.

Oil gas, produced by the vapourization of liquor of distillation of certain mineral oils, is also utilized in incandescent systems.

A special method of producing gas for lighthouse supply is the Benoid system, of which some models were exhibited by the Prussian Ministry of Public Works. An illustration of a generator of this description, as built by Messrs. Thiem & Töwe (of Halle a. S.). is shown in Fig. 1.

In this apparatus air is sucked into a suitable carburetting chamber by means of an automatically controlled revolving drum; as a rule the rotation of the drum is accomplished by a falling weight, the whole arrangement being entirely automatic, and producing an air-gas of constant composition as a result. It may be mentioned that some 1,200 installations of this kind are in use throughout Germany and Russia, for lighting private dwellings, railway stations, &c.; the application of the system to maritime purposes is, however, still the subject of experiment.

An example of the alcohol incandescent lamp is shown in Fig. 2.

A lamp similar to that in the illustration will burn for thirty days without attention, and the writer can testify that the method has now reached a thoroughly reliable stage.

The annular alcohol tank is situated immediately below the conical upper section of the chimney, the alcohol itself being fed up to the burner by means of a wick within a metal tube perforated at its upper end. After a short time the conduction of heat to the alcohol chamber secures that the process is continuous. The intensity of the lamp itself—without the lantern—is about 40 H.K.

In both cases, however, the distribution of light from arc-lamps intended for ordinary purposes of illumination is unfavourable to their use in lighthouses, and this was early realized by J. N. Douglas, who in 1876–1877 originated the adoption of two carbons, placed one above the other, but inclined to the vertical, and the lower negative carbon somewhat projected so as to form an obliquely situated and unobstructed crater.

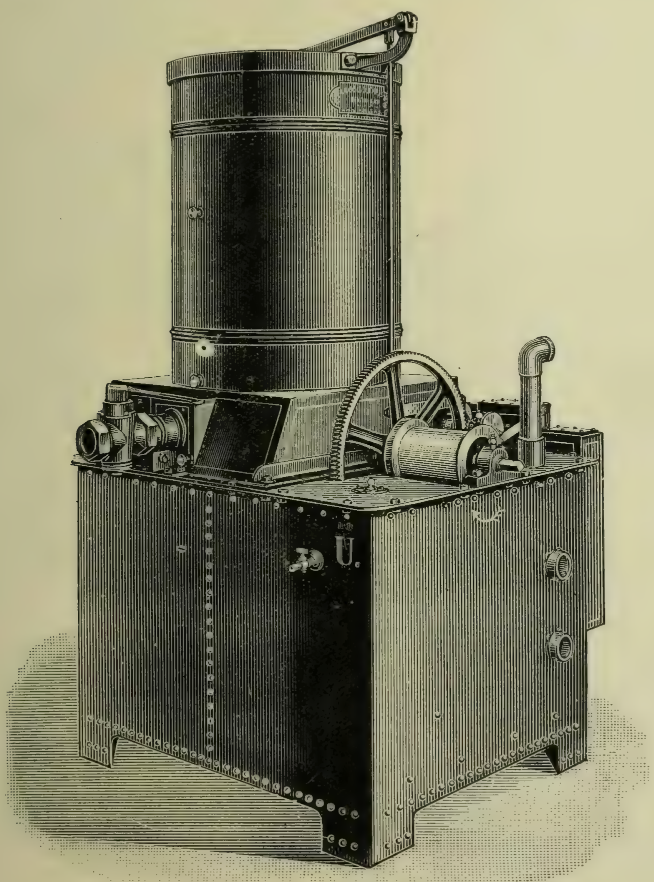


FIG. 1.—Benoid Gas Apparatus.

Some account may next be given of electric illuminants, as applied to navigation. Ordinary white carbon arcs with vertical carbons have long proved of value for lighthouses, search lights, &c. Flame arc-lamps, with inclined carbons, on account of their great intensity are likewise adapted for purposes of navigation.

In 1902 an improved system, involving the use of three projectors with parabolic mirrors, was introduced into the new lighthouse at Heligoland, yielding in all 30,000,000 H.K. A still more recent arrangement, due to Mr. Müller, of the Prussian Ministry of Public Works, and Messrs. the Siemens-

Schückert-Werke, utilizing carbons inclined to one another at an angle of 70° is shown in Fig. 3, the anode being horizontal.

The carbon holders Sd_1 Sd_2, slide on the guides Sl_1, Sl_2, the extremities of the carbons being maintained in their correct positions by insulating boxes of soap-stone.

The motion of both carbon holders is controlled, simultaneously, by an automatic differential arrangement. The motion of the iron cylinder *c*, with the series and shunt solenoids *D* and *Sh*, actuates the lever *L*, about the first *T*, and thus motion is communicated to the carbons.

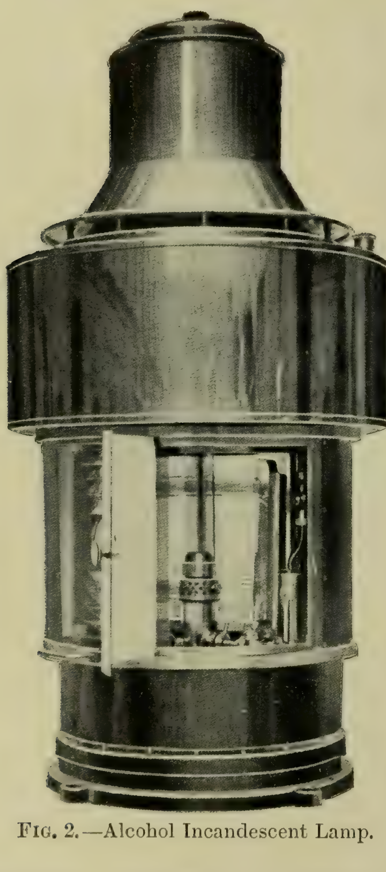


Fig. 2.—Alcohol Incandescent Lamp.

The iron cylinder terminates in a damper *P*. The feeding together of the carbons is provided for by the clockwork *cl*, driven from *s*, and acting on the endless cord 1—2—3—4—5—6—7.

As a result an almost unobstructed beam is obtained from the free crater, but the length of arc must be exceptionally long.

Glow-lamps have also been utilized for maritime purposes, the so-called "focus-lamps" of J. Pintsch, utilizing carbon filaments several millimeters in diameter; some of these are shown diagrammatically in Figs. 4–7.

It is possible, however, that metallic filaments will play a more important rôle in this connexion in the future.

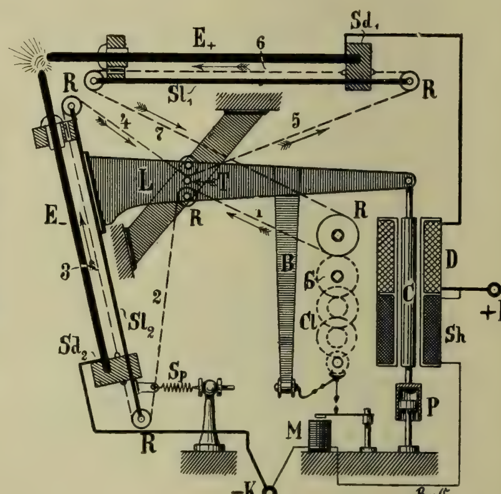


Fig. 3.—Regulating Apparatus for Use in Connexion with Inclined Carbons for Searchlights.

General Mechanism of Illuminating Apparatus.

Having dealt briefly with the sources of light employed in maritime illumination, some account will now be given of the accessory apparatus for use therewith.

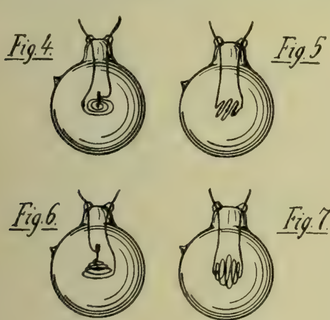
The importance of this subject will be gathered from the fact that according to the "Verzeichnis der Leuchtfeuer aller Meere," issued by the German Government Naval Department, there are over 1772 lights of all kinds in use on the North Sea.

As it is often inadmissible to use colour as a means of distinction, recourse has to be had to the method of making the light intermittent, in

order to enable different lights to be identified from the others. Therefore the design of intermittently acting and revolving systems is of considerable importance.

Equally vital is the design of suitable lenses and reflecting apparatus in order to concentrate the entire light given by a source in all directions within a certain narrow area. For instance, if the light from a source yielding a M.Sph.C.P. of 40 H.K. be concentrated within a solid angle corresponding to $\frac{1}{25}$ of the total imaginary spherical surface surrounding the light, the intensity in this direction becomes virtually 25×40, *i.e.*, 1,000 H.K. Revolving apparatus, however, must be installed in order that all parts of the horizon can be reached in succession.

Until recently this revolution of the illuminating apparatus was achieved



either by means of regulated clockwork, driven by a heavy weight, or by an electric motor.

An ingenious arrangement, introduced by the Pintsch, A.G., and shown in Fig. 8, depends on an entirely different principle ; the revolving apparatus consists of a small paddle-wheel driven by the pressure of the gas utilized with the lamp, the spindle of which is connected by gearing to the revolving lense-arrangement. Only a very small amount of gas is needed to keep the light in movement, the greater portion flowing through a separate pipe direct to the burner. The whole apparatus consumes about 25 litres per hour, and yields 3,000 H.K.

Another arrangement for the same purpose introduced by the Prussian Ministry of Public Works, utilizes the Benoid apparatus ; this was found particularly serviceable in cases in which it was desired to improve the existing arrangements in an economical way, and without having to remodel the whole installation.

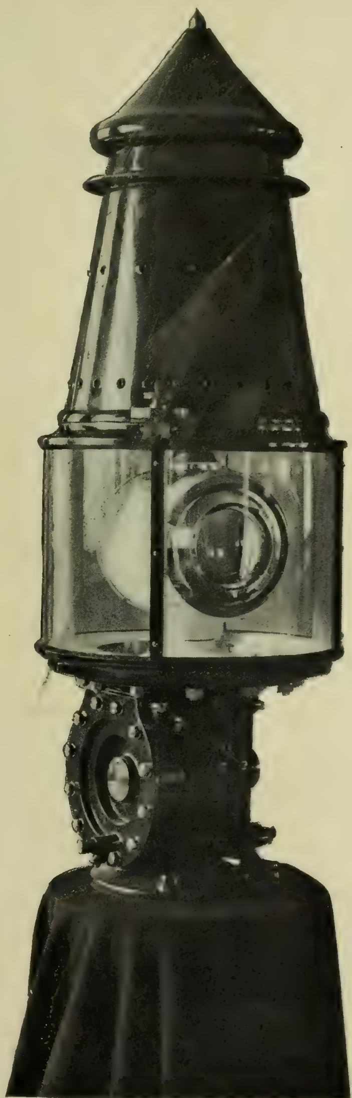


FIG. 8.—Revolving Concentrating Lantern for Lights of Low Intensity.

The Benoid gas apparatus, however, demands an outside source of mechanical power, and this was furnished by a small hot-air motor of about $\frac{1}{40}$ H.P., which also serves to accomplish the revolution of the light.

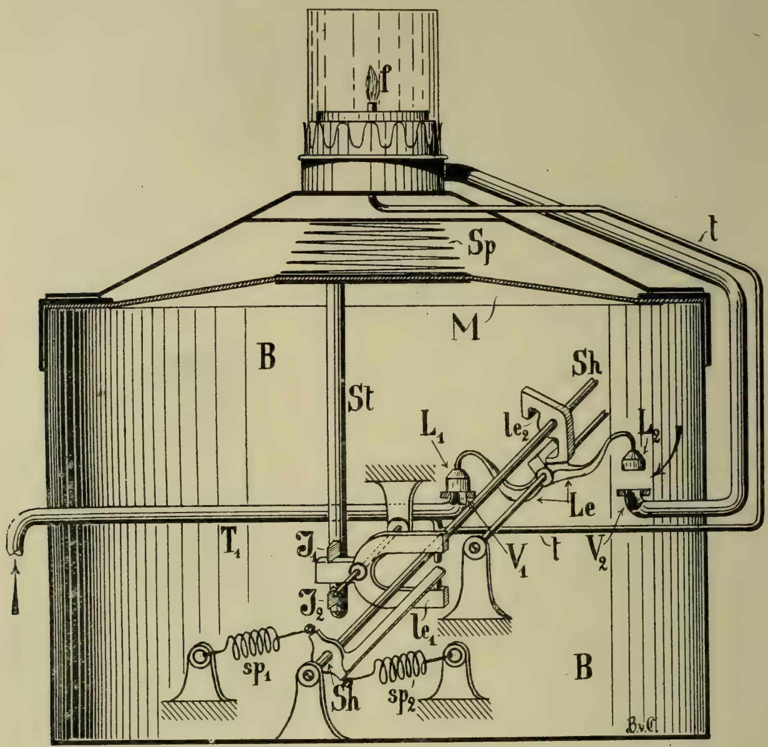


FIG. 9.—Automatic Intermittent Flashing Arrangement for Use with Buoys.

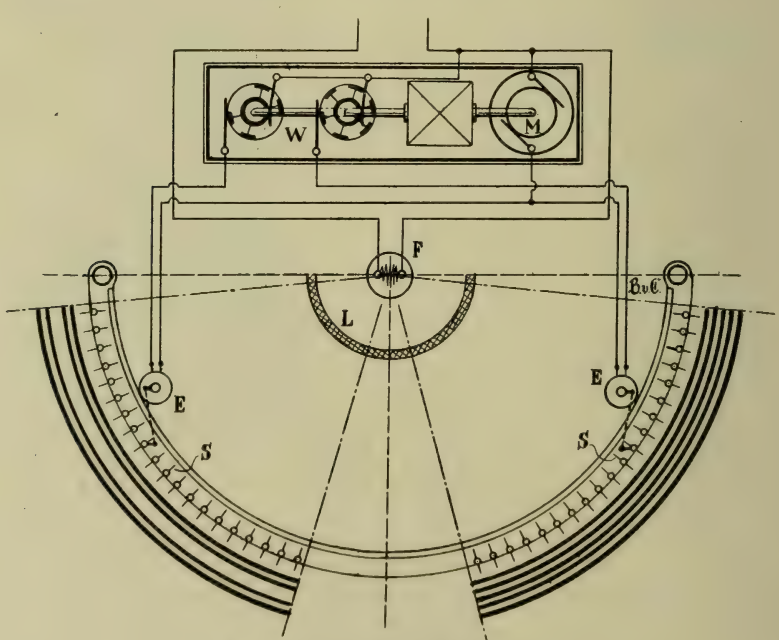


FIG. 10.—Group-flashing Mechanism.

There are other cases—*e.g.*, illuminated buoys—in which the source of light must be visible simultaneously from all quarters of the horizon, and where an intermittent flashing arrangement is still desirable, but must be secured by different means. Such an arrangement as that shown in Fig. 9 is then employed.

Here a cylindrical box B communicates by a tube T_1 with the regulator serving to control the flow of gas from the reservoir. The top of this box is closed by a leather membrane M, pressed down by a spring Sp. T_1 terminates in a small valve V_1, which can be operated by the lid L_1, attached to the lever L_e.

The position of L_e is determined by the springs sp_1, sp_2, thus causing the small lever l_2 to tilt over to the left or right, with the motion of the shaft sh.

The second arm of L_e likewise controls a valve V_2, through which the gas passes from B to the burner. Now if the position of sh and L_e be such that V_1 is open, gas passes in to B, and lifts the membrane M, thus raising the rod St, and causing the lever L_e to tilt over, and close V_1 again, while the gas passes to the burner through the now open V_2. Subsequently, however, the pressure in B falls, the diaphragm M is likewise lowered, and the whole process begins anew. Of course the burner is provided with a continuously burning pilot-flame f. A slight modification of this apparatus enables it to be worked on the "group-flashing" principle.

Group-flashing lights usually involve the illumination of a certain portion of the horizon with a steady light, while information as to the fairway may be conveyed in another direction by intermittent flashes. Such an arrangement is usually achieved by using a system of Otters screens as shown in Fig. 10.

A focus lamp of 300 H.K. (similar to that shown in Fig. 7) is surrounded by a series of Fresnel lenses L. On either side groups of movable screens ss may be used to obscure the lights. The screens ss rotate about a vertical axis, and are controlled by the action of the electromagnets EE, subsequently, returning to their position owing to the action of a spring. Possibilities of revolving motion are provided by the small electric motor M, and the switch gear W.

It is thus possible to secure a revolving light on the starboard, a fixed light announcing the condition of the fairway in the centre, and a group-flashing arrangement to larboard.

Some interesting examples of group-flashing light, constructed by J. Pintsch & Co., and capable of giving a beam of very high intensity, were also exhibited. These lights have been applied at the Stilo lighthouse in Pomerania and at the Hörnum installation on the isle of Sylt.

The exhibit of this type utilized a lens with a focal distance of 250 mm., having 3 dioptric and 7 katadioptric zones, a vertical strip dispersor, causing a horizontal divergence of 10° 30′ in a horizontal direction, and 11 vertical Otters screens.

The arc itself remains stationary, and the optical arrangement rotates round it, driven electrically by a motor installed in the pedestal. The design of the light enables an intermittent light of four flashes, followed by an interval, then two flashes, followed by the same interval, then two flashes, and so on. It is possible to obtain an exceptionally high intensity (stated to be 75,000,000 H.K.) in one direction, in conjunction with a group-flashing arrangement.

Mention may also be made of an interesting device for small lights, designed to indicate the existence of a fair way by means of a fixed light without giving information as to its extent, &c.—namely the "Mangin" mirror. This consists of a meniscus lens, the outer convex surface of which has a greater radius of curvature than the inner concave one. The back surface of the lens is silvered, and it is claimed that a parabolic effect is obtained by the joint action of reflection and refraction comparatively cheaply, as compared with the ordinary parabolic mirror. The arrangement, however, is only approximate, and such mirrors are said to be somewhat liable to

fracture from the heat of intense sources.

Miscellaneous.—Special Devices.

At the present time one of the direct objects of apparatus for lighthouses, &c., is to render their action automatic, and thus simplify the work of those in charge, or even dispense with their constant vigilance.

In particular there is scope for automatic devices to call the attention of the keeper to any marked diminution in the intensity of the light, either through the unsatisfactory automatic regulation of the arc-lamp, or the partial failure in the required pressure for a petrol-air apparatus, &c. For this purpose recourse has been had to the action of selenium cells, the electrical resistance of which is much reduced when acted upon by light. The increase in resistance in an exposed cell, corresponding to the failing intensity of a light, may be utilized to ring a bell and attract the keeper's attention.

Another more simple method of achieving the same result is by the use of "thermal dilatation," according to which the metals, having a different co-efficient of expansion and in intimate contact, are played upon by the radiation of the flame. A notable diminution in the latter causes the metal contacts to come together, complete the electrical circuit, and ring a bell. Entirely automatic action is demanded by buoys placed in remote situations, which can only be visited very occasionally.

Fig. 11 is an example of the application of the selenium cell to the automatic lighting up and extinguishing of lights on buoys as devised by Prof. E. Ruhmer, of Berlin. Ruhmer's cell is enclosed in an exhausted glass envelope, through which the rays of light pass and play upon the cell. The cell is in connexion with a battery of dry cells and a relay enclosed within a water-tight metallic case.

This arrangement is attached to the buoy, and used in conjunction with an arrangement similar to that shown in Fig. 9, the controlling lever being actuated by a relay, which in turn is acted upon by the current passing through the circuit containing the selenium cell.

During the night the resistance of the latter is high—perhaps 8,000 to 40,000 ohms—and the light is then allowed to burn. When daylight comes the resistance of the cell falls to about one-hundredth of its "darkness-value," and the alteration in current extinguishes all but the pilot-flame.

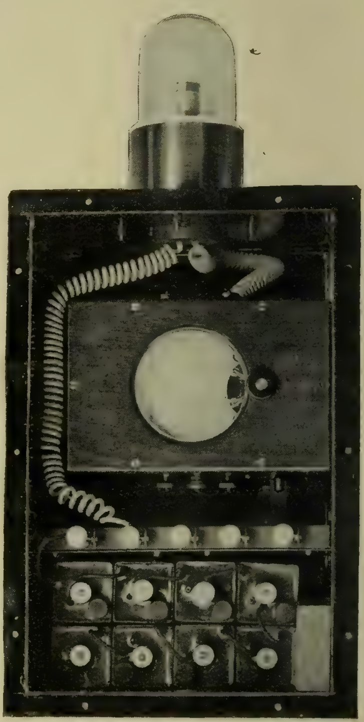


Fig. 11.—Ruhmer Selenium Cell applied to the Automatic Lighting and Extinguishing of Buoys, &c.

It is stated that the arrangement has stood the test of practical experience, having been successfully employed in connexion with beacons at various points round the coast of Germany, &c.

The Employment of Mirrors in Photometry.

By Lancelot W. Wild.

The days of the simple bar photometer with fixed lights at each end are numbered. So long as measurements of horizontal intensity only sufficed, such a simple arrangement was all that was required. Now, however, that the importance of light distribution is acknowledged, and with light sources running up into thousands of candle-power, more complicated arrangements are rendered necessary.

Arrangements for tilting or spinning the light source, or for tilting the photometer or a part thereof are seldom entirely satisfactory, and are generally wanting in flexibility, hence the employment of mirrors in one form or another is gradually replacing all other arrangements for testing lights at angles above or below the horizontal. Mirrors suitably arranged are commonly employed also for integrating the candle-power of a light source at several angles, so as to give in a few measurements either the mean spherical or mean hemispherical candle-power.

In using mirrors in photometry it is necessary to use caution and not to employ an arrangement without first investigating the magnitude of the errors that may be incurred.

The light that falls upon a mirror is distributed in three ways: first, there is direct reflection from the front of the glass; next, there is direct reflection from the silvered surface, a portion of the light being absorbed in transit through the glass; lastly, some of the light is scattered, the mirror behaving, in less degree but in the same manner, as a white matt surface, such as blotting paper.

The efficiency of the front surface is greatest when the angle of incidence is large. The ratio of light leaving the glass to that entering the glass is highest when the angle of incidence is small, as then the rays have a smaller thickness to pass through. The total efficiency of the mirror is not, however, a maximum at a small angle of incidence, as, although the absorption of that part entering the glass is at its minimum, the percentage reflected from the front and not suffering from absorption is also a minimum.

The writer has generally found a maximum efficiency of the mirror as a whole with an angle of incidence of about ·40 degrees. Since the efficiency of a mirror varies in some way with the angle of incidence, it follows that this angle should always be a fixed quantity. An angle of 45 degrees is generally found convenient, and has the advantage that the mirror is then working at near its maximum efficiency.

Dispersion causes a theoretical error unless both the distance from the light source to mirror and from mirror to photometer disc is always fixed, as the effect of dispersion is to cause the mirror to radiate light as if it was itself a minor light source. The error due to dispersion should be a maximum when the sum of the two distances is small and their difference comparatively large. The writer has, however, failed to find any error caused by dispersion, provided that the sum of the two distances does not fall below three feet and the smaller distance does not fall below one foot. In ordinary practice it would appear, therefore, that mirror dispersion does not give rise to any appreciable error.

It is, perhaps, hardly necessary to add that mirrors employed in photometry should be of best English plate-glass and free from blemishes. They should also be at all times kept scrupulously clean, even when out of use for some time, and are best kept in a dark room and away from dust or chemical fumes. In any case, the absorption of mirrors should be re-

determined from time to time as they may darken even with the greatest care.

The best way to determine the absorption of a mirror is to test a light of known value with the mirror and again without it. If one has a truly reversible photometer, however—and such things are about as rare as radium —the absorption can be easily determined by comparing two incandescent lamps on the same circuit, one at each end of the bar, a second test being made after reversing the positions of the lamps.

A photometer mirror must be large enough not only to take in the primary light source, but also any globes or shades that may be attached thereto. An instructive experiment is to test a half-ampere Nernst lamp with vertical filament and fitted with an alabastrine globe. Then if a small piece of black paper is fixed to the globe so as to hide the filament it will be found that the candle-power is only reduced thereby about 20 per cent. Obviously, then, more light is received from the globe than from the filament direct.

The efficiency of a mirror one-eighth of an inch thick is generally about 89 per cent, and one-quarter of an inch thick about 80 per cent, with an angle of incidence of 45 degrees. These figures, however, are approximate only, and vary considerably with different samples of glass.

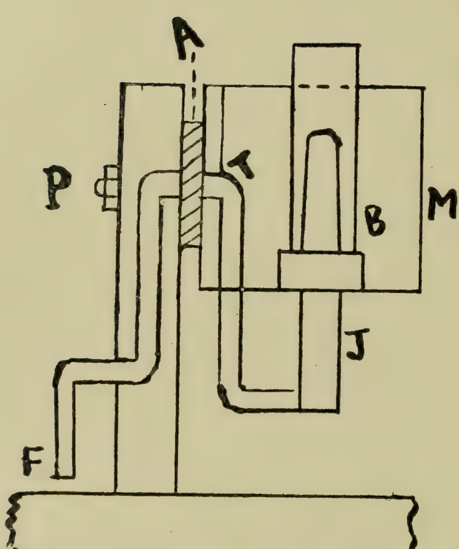


FIG. 1.

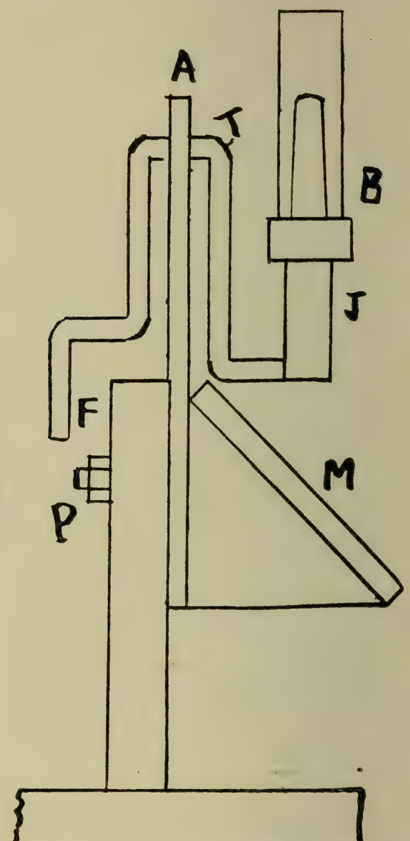


FIG. 2.

The writer will now proceed to describe a few methods of employing mirrors in photometry, confining himself to methods which he has employed himself, and of which he has had a

sufficiently extended experience to be able to recommend them as safe methods.

Figures 1 and 2 show an arrangement adopted for testing incandescent gas burners; both are side views of the apparatus. Fig. 1 shows the apparatus in position for determining horizontal candle-power, and Fig. 2 for vertical candle-power. The mirror M is mounted on the arm A, and they both revolve together round the pivot P, which is situated on the photometric axis of the bench. From the end of the arm A is hung a bent brass tube T, so that when the arm and mirror are revolved the tube is always vertical, and the burner is always opposite the centre of the mirror and at the same distance from it. At J is a water joint which enables one to revolve the burner on its vertical axis so as to obtain readings of the candle-power from all sides of it in turn. Gas is supplied through a flexible tube connected to the brass tube at F.

With this arrangement the candle-power can be determined not only horizontally, but at any desired angle below the horizontal, and at any angle above the horizontal up to 70 degrees. At higher angles the heat from the burner would injure the mirror. It will be observed that the angle of incidence is always the same, namely, 45 degrees, that the light source is a constant distance from the mirror, and also that the beam of light is received by the photometer screen along the ordinary photometric axis. The writer finds that with this apparatus he can, when the burner and standard are burning correctly and all adjustments made, obtain sufficient readings to determine the mean spherical candle-power of a "C" or inverted burner in ten minutes with an inaccuracy probably not exceeding 1 per cent.

The same apparatus could be easily modified to take other light sources, such as electric incandescent lamps, but when it comes to anything heavy, such as arc-lamps, an alteration has to be made. An arc-lamp may be separately suspended from a cranked bar fixed from a beam overhead, as shown in Fig 3. The lamp is shown in the position for testing its vertical candle-power. Means must be provided for indicating both the angle of the cranked rod and of the mirror, and both must be brought to the same angle. A movable photographic view-finder suitably mounted on the photometer bar is a useful adjunct with such an arrangement.

The great difficulty encountered in the testing of arc-lamps is the unsteadiness of the light. This is in part due to the shifting of the arc, and can be greatly reduced if an arrangement is employed of throwing the light from opposite sides of the lamp on to the screen simultaneously. A pair of mirrors to effect this is shown in Figs. 4

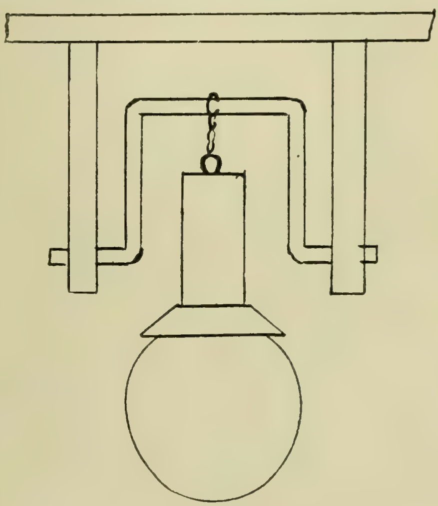


Fig. 3.

and 5. Fig. 4 is a view looking from the photometer screen, and Fig. 5 is a side view. Two mirrors MM are fixed on to the ends of two swinging arms pivoted at P. The arc is hung in front of P so that rays from either side fall upon the two mirrors respectively, and are reflected on to the screen. In Fig. 4 the mirrors are set for determining the candle-power of the arc at 45 degrees below the horizontal. In Fig. 5 one mirror has been removed and the other is set for taking a measurement at 90 degrees below the horizontal. In the writer's apparatus the two mirrors touch at their edges when 70 degrees below horizontal.

For taking measurements at 80 and 90 degrees one mirror is turned up out of the way and covered with a black cloth, a single mirror only being used.

It will be noted that in this arrangement the light rays do not full upon the screen along the normal photometric axis, but are inclined thereto. This circumstance causes a theoretical error when the screen is shifted, due to varying angle of incidence at the screen, difference between length of path of rays to distance measured on scale, and varying angle of incidence at the mirror. These errors are, however, quite negligible as a rule. In the writer's apparatus the mean radius of mirrors is 15 inches and the distance between the lights 250 inches, the angle of incidence at the photometer screen varying as the comparison box is moved from $3\frac{1}{2}$ degrees for infinite candle-power up to 7 degrees for 16 candle-power, at which angle the sum of the errors due to change of angle amount to about $\frac{1}{2}$ per cent only.

A method of integrating the mean horizontal candle-power of electric incandescent lamps without spinning them is most desirable. The chief objections to spinning are, first the difficulty of securing good contacts between the collector rings and brushes. Secondly the possibility of the light distribution being altered by the deformation of the filament. Thirdly, the impossibility of using a flicker photometer head.

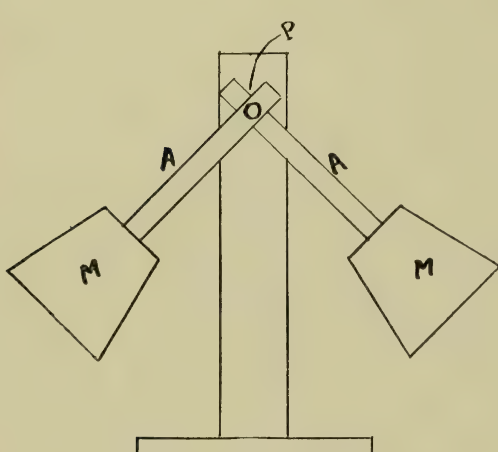


Fig. 4.

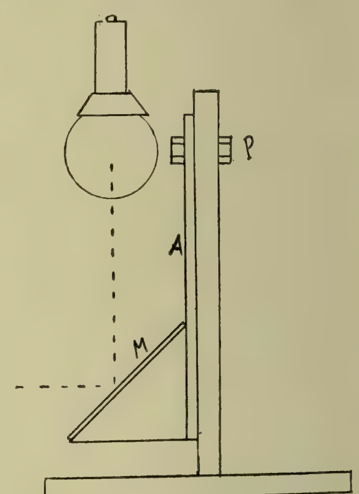


Fig. 5.

Figs. 6 and 7 show an arrangement of mirrors for integrating mean horizontal candle-power. Fig. 6 is a view as seen from the screen, and Fig. 7 a sectional side view. An octagonal box with sides sloping in at 45 degrees is lined with 8 mirrors. The incandescent lamp to be tested is fixed in the position shown in Fig. 7, so that the rays fall upon the mirrors and are reflected upon the photometer screen. The screen sees 8 images of the lamp all horizontal, but at eight different angles round the axis. The direct light from the tip of the lamp is of course blocked out by a suitably placed screen. The writer's apparatus has 8 mirrors, and the lamp-holder can be turned through an angle equal to the sixteenth of 360 degrees, so that, one reading having been obtained giving the sum of the candle-powers at 8 angles, a second reading can then be obtained giving the sum of the candle-powers at the 8 intermediate angles. With lamps of ordinary construction, however, the difference between these two readings seldom amounts to as much as 1 per cent,

so the second reading is as a rule hardly necessary.

As in the last example, the rays do not fall upon the screen along the photometric axis. In the writer's apparatus the angle of incidence on the screen varies only from about 3 to 5 degrees in practice, and angle errors are quite infinitesimal and beyond detection.

For lamps that will not burn in any position the apparatus can be turned up so that the lamp hangs vertically, and another large mirror at 45 degrees fixed underneath for turning the rays on to the screen.

frequently recalibrated to compensate for the effect of dirt and darkening of the white paint. The Mathews mirror arrangement is extremely unwieldy and inflexible, and the position of the mirrors have to be specially adjusted to compensate for the failure of the photometer screen to obey Lambert's law at very large angles of incidence. Both the Mathews and Russell-Leonard methods require that either the lamp shall be spun or else that a number of readings (six or eight) shall be taken. The Russell-Leonard mirrors can be calibrated with a lamp tested for horizontal candle-power in

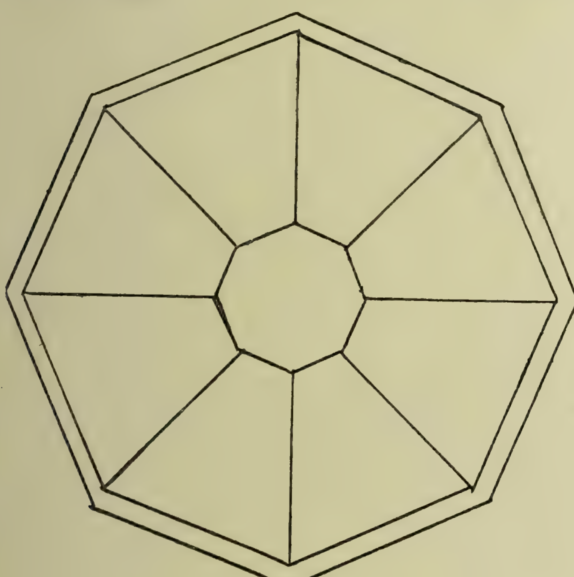


FIG. 6

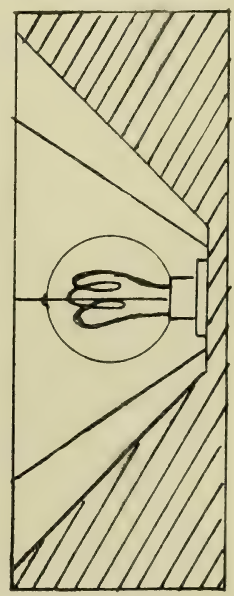


FIG. 7.

two directions only if all mirrors but two are blocked out and the lamp is placed in such a position (requiring an extra lamp-holder), as to throw on to the screen two horizontal images.

Although mean horizontal candle-power is still called for, the writer now more often tests lamps for mean spherical candle-power. There are at present but three methods that can be employed that give readings sufficiently quickly for everyday work. These are the globe photometer, the Mathews integrating mirror system, and the Russell-Leonard mirror system. The globe photometer suffers under the disadvantage that it can only be calibrated with a lamp of which the mean spherical candle-power has previously been determined by some other sure method. Also it must be fairly

The writer, having had no personal experience of either the Globe or Mathews photometers, will confine himself to a description of the Russell-Leonard system.

Fig. 8 shows a view as seen from the photometer screen, and Fig. 9 a sectional side view. A conical box is lined with mirrors at various angles, all, however, being at 45 degrees to the back of the box. The lamp is hung

vertically, and means must be provided either for spinning it or for turning it on its vertical axis. The writer prefers the latter, as, although more tedious, it allows him to take advantage of being able to use a flicker head. The mirrors are not set at equal angles, but at 7·2, 22, 38·7 and 61 degrees above and below the horizontal, so as to divide up the Rousseau diagram into equal distances between the ordinates, as first recommended by Mr. Russell. The mirrors are placed alternately on either side of the lamp, so as to reduce the diameter to the smallest possible dimensions. In the writer's apparatus there are 8 mirrors and the outside diameter is 18 inches, the mean radius being 7½ inches. The angle of incidence on the photometer screen varies in practice from about 4½ to 6½ degrees, and the angle error is practically nil. It would have been better to have employed more mirrors, perhaps, but this would have entailed making the apparatus of larger diameter, would have necessitated a longer bar, and would have increased the angle errors. The writer believes that the error caused by using an insufficient number of mirrors seldom is as much as ½ per cent, though on extraordinary lamps it would doubtless greatly exceed this.

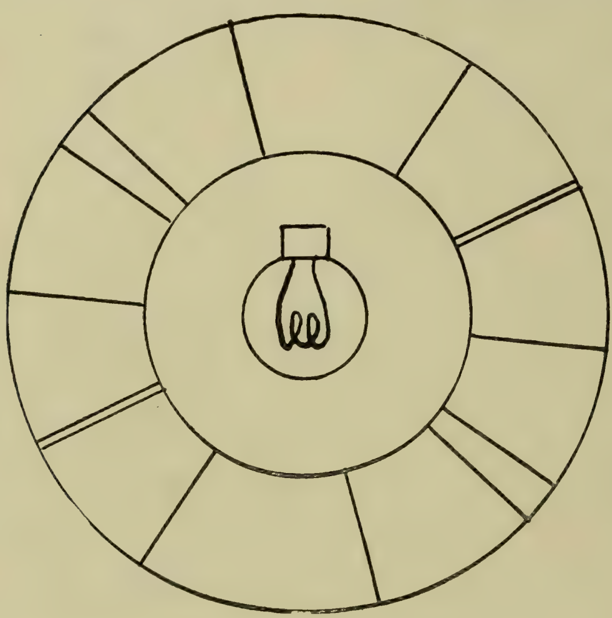


Fig. 8.

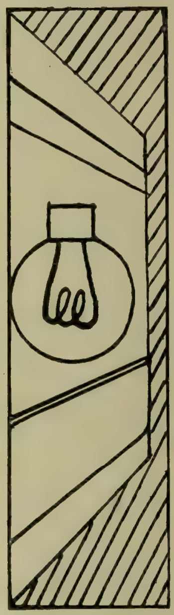


Fig. 9.

With integrating photometers the apparent candle-power of the light source is multiplied by the mirrors, and consequently they necessitate a long photometer bar. In consequence of this the risk of error from light reflected from walls or bench is greatly enhanced. It is absolutely necessary, unless the whole photometer is placed in a very large room, that great care be taken in the screening. Screens on the shooting gallery principal should be so placed that when the eye is placed in the position that the photometer screen is to occupy neither walls, ceiling, nor bench will be visible either directly or in the mirrors.

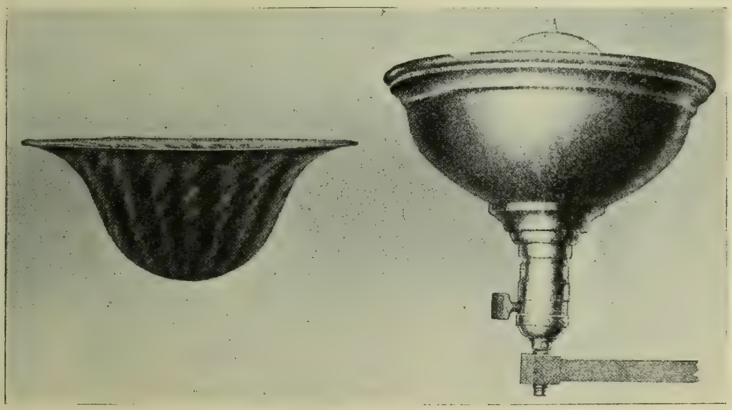
REVIEWS, ABSTRACTS, AND REPRODUCTIONS.

Indirect Illumination.

By A. D. Curtis and A. J. Morgan.

(*Trans. Illum. Eng. Soc.*, Dec., 1908.)

The term indirect illumination is usually employed to designate that form of artificial lighting which depends upon reflections from ceiling, walls, or other surfaces, the source of light being concealed. It has been recognized that indirect illumination is excellent from the standpoint of eye-comfort, but the system has been considered too expensive and inefficient in operation to be feasible for common use. The present paper contains a discussion of a system of indirect lighting which is believed to be both practical and economical.



Figs. 1 and 2.—Reflector and Single-Unit Fixture.

The prime requisites for an indirect-lighting system are low-priced high-efficiency lamps, and reflecting surfaces having low absorption. When gas is used a satisfactory lamp is the high-grade incandescent-mantle burner. When electricity is employed the tungsten lamp proves excellent for the source of light.

The character of the reflector employed has a vital influence on the results. The necessity for efficiency and durability is evident. It is equally important for the reflector material to be capable of being moulded so that the output may be uniform and correct in design. The reflector should be so arranged as to permit of easy and thorough cleaning, and the shape should be such as to produce the desired illuminating effects in the room.

The reflector selected is of an inverted bell shape, containing circular and vertical corrugations which throw the rays of light to the ceiling without shadows. The reflector consists of a single piece of blown glass coated on the outside with pure silver, the reflecting surface being of high efficiency. This same general type of reflector has been in use for several years.

The bell-shaped reflector is fitted into a spun-brass casing. On gas fixtures the casing rests on the base of the mantle burner like a globe. On electric fixtures the casing can either be suspended by chains or supported from below.

The arrangement described above can easily be adapted to old chandeliers. Unless the chandelier arms are very heavy, it can be applied to any electric chandelier where the sockets are pendent, because the arms do not cast annoying shadows on the ceiling; the light comes from many directions when passing the arms, due to the corrugations.

The lighting unit should be at, or near, the centre of the room, though side lamps have been used with satisfactory results. It is not essential for the walls to be light coloured, as most of the light is directed to the ceiling.

While it is true that there is a loss of light in indirect as compared with direct illumination, another factor enters to overbalance the loss. The more easily details can be seen the more effective is the illumination. When there is a bright naked lamp in front of the eye, the pupil contracts, and therefore the eye takes in less of the light and the things that are illuminated are not seen as clearly as they are with less light and a wide-open pupil. Hence the fact that there may be less light with indirect illumination does not necessarily mean that one sees less clearly; on the contrary, he really sees better.

Of course, the system of illumination described herein, is not entirely practical with beamed ceilings or those of dark tint, but in the majority of instances the ceilings are light and the conditions are favourable. There are at present about fifteen experimental installations of the system in use among professional and business men in their residences and offices in this city. Without exception the users are enthusiastic in its praise, and are impressed with the eye-comfort derived by its use.

The lighting units can be arranged in a variety of ways. The fixtures can be installed in single units, or multiples thereof, either electric, gas, or combinations of both, and it is practical to illuminate in this way, not only residences but halls and auditoriums.

A unit of one reflector and one 100-watt tungsten lamp (about one-half watt per square foot) or a good gas mantle burner (consuming about $4\frac{1}{2}$ cubic feet per hour) gives adequate illumination in a room up to 15 feet square. The low consumption makes the cost very reasonable.

It is a peculiar fact that the impression formed by almost any one coming unexpected for the first time into a room illuminated by the indirect method of lighting is rather likely to be adverse if any thought is given to the lighting at the time of entering the room. A great many—in fact a majority—do not at first note anything out of the way

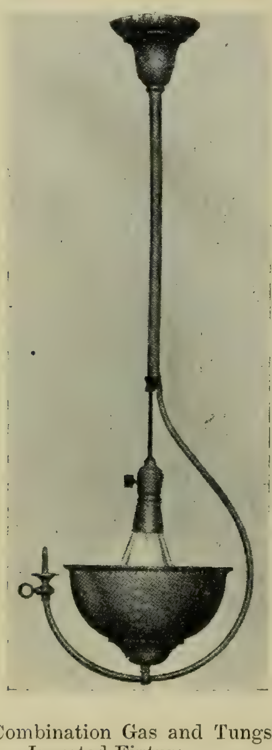


FIG. 3.—Combination Gas and Tungsten Inverted Fixture.

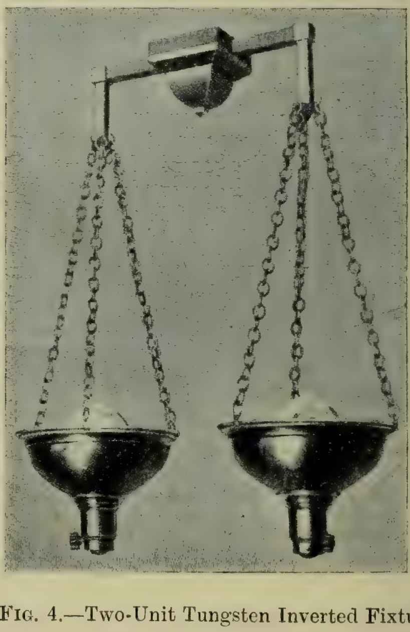


FIG. 4.—Two-Unit Tungsten Inverted Fixture.

or unusual in the lighting of the room, and sometimes an hour may elapse before the subject is mentioned. Many feel lost without a source of light in full view, and the almost universal first opinion, when thought is given to the lighting, is that the lighting is insufficient. This opinion is almost always changed within a very few moments, and an experience of an hour or at most two hours means a convert to the indirect system of lighting.

The authors are indebted for valuable suggestions to members of the Illuminating Engineering Society, and also to members of the Chicago Opthamological Society, who were emphatic in the assertion that many eye troubles are caused by the present method of artificial illumination in which the delicate mechanisms and nerves of the eye are subjected to the direct rays of the intensely brilliant modern lighting units. Mr. J. R. Cravath acted as consulting illuminating engineer in connexion with the design of the reflector and the technical points involved.

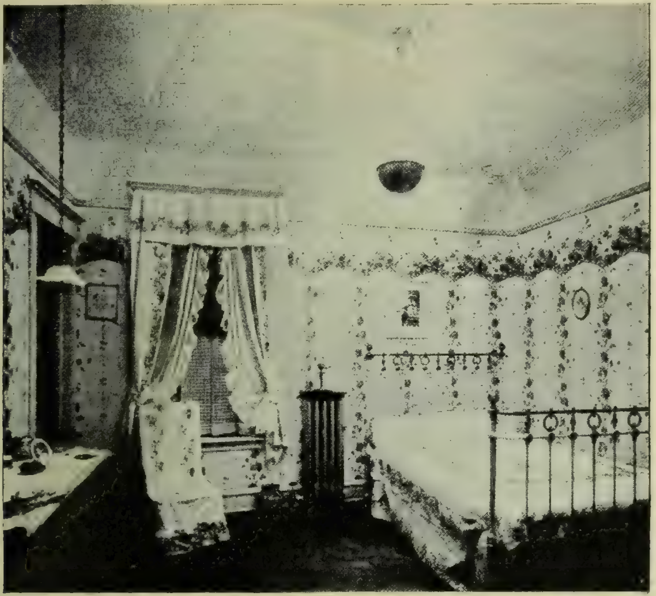


FIG. 5.—Illumination of a Room (12×14) by Means of 60 Watt Inverted Unit.

DISCUSSION BEFORE THE CHICAGO SECTION.

Mr. J. R. Cravath referred to the fact that in the system described by Mr. Curtis most of the rays were thrown on the central part of the ceiling so as to undergo only one reflection before reaching the actual working place. In this respect the method differed from cove-lighting, in which a light was reflected to and fro a number of times; therefore, in the system adopted by Mr. Curtis the efficiency was greater.

Indirect illumination was, in general, much more comfortable in every way than direct, provided the side walls of the room were not too highly illuminated. Another characteristic was the absence of glare from highly glazed paper, because the light in the case of an indirect system comes from such a large area that reflection does not bother one.

From the economical standpoint indirect lighting had the advantage of enabling us to reduce the number of outlets in a room and yet to get a satisfactory diffusion of illumination. This might occasion slightly more energy than in the case of direct lighting, but the saving in the first cost would compensate for this.

Mr. V. R. Lansingh described an example of indirect illumination at the office of the Edison Co., in New York.

The ceiling was very high, and being, like the walls, light in colour, the illumination in foot-candles was excessive, and the general effect trying to the eye; there was no place where it could rest. The trouble might not have been so great had the walls been dark in colour.

Mr. Albert Scheible inquired whether the corrugations on the reflector were put there for mechanical reasons or whether they increased the distributing efficiency. In reply **Mr. Cravath** stated that they were put there to avoid streaks on the ceiling.

Mr. G. H. Jones thought that it would often be necessary to provide outlets on the side walls in addition to the central fixture, so as to provide local lighting with portable lamps. **Mr. Cravath** said it was not desirable to eliminate shadows entirely, and he thought there ought to be some shadow in the case of artificial lighting just as in the case of daylight. In reply to other queries he gave some particulars of the plating of the mirror consisting of a pure silver, resulting in an elastic material that would expand and contract with the glass when heated, and cool without breaking the glass or tarnishing.

Mr. George Loring said that this was the first time for many months that he had been able to stay in a room artificially illuminated without being inconvenienced by the glare from sources of light when he looked in different directions. Yet many people noticed the apparent absence of a lighting source, and disliked the impression to which it gave rise; however, they afterwards became accustomed to it; it was, in fact, a system that would wear well.

DISCUSSION BEFORE THE PHILADELPHIA SECTION.

In addition to the points referred to above, some other interesting questions were raised in this discussion.

Mr. H. Calvert gave some photometrical details of the illumination obtained by four primatic clusters, having a total candle-power of 960, and four indirect lighting fixtures, each containing a 100 watt Tungsten lamp, and providing a total candle-power of 320. The watts per square foot were in the first case 3.43 and in the second 0.57.

Mr. W. A. Evans described some recent photometrical tests on the light from mercury vapour lamps in combination with Tungsten lamps, which, he said, was found to resemble diffusion daylight very closely. Observation also showed that when a Tungsten lamp with a frosted prismatic reflector, giving an illumination of 8 candle-feet, was turned towards the ceiling the illumination was decreased to 2 foot candles, or even to 1.5. foot-candles; yet, owing to the fact that the lighting source was hidden from view, one could read with more comfort by the diffused illumination than by the more powerful direct lighting. He thought however, that there were three factors which determined the amount of light required for reading purposes, namely the colour of the light, the diffusion, and the hiding of the source of light from the eyes of the reader.

Mr. C. O. Bond said that previous systems of indirect illumination had proved a failure, because arc-lamps were used; this was due to the unsteadiness of the light.

Mr. Toerring remarked that absence of shadow was often an advantage for office-work; for instance, one could see to the bottom of a deep card-index box, and read the names on the cards without encountering annoying shadows.

Dr. Norman Macbeth said that although indirect illumination might be good in theory it was difficult to reconcile many people to it in practice; in any case he thought that the variety of diffused illumination commonly termed "shadowless" could not be good, for the absence of shadows was neither natural nor desirable. Dr. Macbeth also quoted a paper by Mr. Preston Millar before the Engineering Illuminating Society, in which he showed that it was found to be more difficult to read a placard illuminated with a given intensity by the inverted system, than by direct lighting—apparently owing to the pupilary contraction caused by a bright general illumination; the results showed a demand for 65 per cent higher intensity in the case of diffused light.

Among other remarks before this section reference may be made to those of **Mr. Saunders,** who stated that about ten years ago **Prof. Elmer Gates** came to the conclusion that the trouble caused by reflected light was due to polarization, and he therefore employed a special matt surface, covered with certain pigments and chemicals. He also claimed to have secured a distinct gain in efficiency by changing the wave length of the violet and ultra-violet rays into light from the other end of the spectrum.

The Ventilation of Photometer-Rooms.

(Abstracted from the Report of the Committee of the American Gas Institute on 'Methods of Taking Candle-power of Gas,' October, 1907.)

In this report attention is drawn to the importance of properly ventilating rooms used for the photometry of gas. The committee recommend that such rooms should be not less than 12 ft. in height, and not less than $8\frac{1}{2}$ ft. wide. Where gas from only one supply is to be tested the room should also be not less than 14 ft. 9 in. long, a further 1 ft. 6 in. being allowed for each additional supply and separate meter added.

Besides good ventilation it is essential to secure equable temperature and absence of draughts in the room. For this purpose it is recommended that the room devoted to photometry be enclosed within a second outer "jacketing" room, from which a steady supply of pure and warm air can be obtained by means of suitable light-tight openings. These should extend round the entire room, and for a room of the prescribed dimensions should embrace not less than 10 square feet, made up of twenty-four registers each 6 in. $\times$ 10 in., or their equivalent.

Such a room will permit of the continued presence of two persons, a 5-foot per hour gas flame, and the flame of a pentane lamp, without undue vitiation of the atmosphere.

It is frequently assumed that such vitiation affects different flame-sources of light in a similar manner and to a similar degree, and therefore should not seriously affect the ratio between their candle-powers. Actually, however, the results of the experiments of the committee on this point, shown in Figs. 1 to 7, suggest that the influence on candles and the Edgerton, Elliott, and Pentane standards respectively differ considerably.

These charts, of course, are made out on the assumption that corrections for carbonic acid and humidity have not been applied to the lamps. Moisture in the air is particularly influential, and some method of raising the humidity in winter and reducing it in summer, so as to approach a fixed normal value, is desirable.

It could hardly be expected that any such formula would be applicable to a flame of varying composition such as changeable gases containing different quantities of air. In comparing a gas flame against another flame standard, we must either have normal atmospheric conditions in the room or we must be able to feel sure that any change in these conditions affects both the flames of the standard and the gas tested in a similar way. When a gas-flame is compared with an electric lamp all such alterations become of even greater importance, for the incandescent glow-lamp is, of course, unaffected by atmospheric conditions. The range of absolute variation of the pentane lamp due to humidity alone, during the entire year, has been found by Mr. J. B. Klumpp in 1905 to approach 25 per cent.

In the laboratory of the Bureau of Standards at Washington the air in the photometer-room is freed from excessive water-vapour by being passed over cooling brine-coils.

Finally, fluctuations in the temperature of the photometer-room may cause marked variations in the candle-power of gas by affecting the partial condensation of some of its constituents. The temperature of the water in the meter is also a factor to be borne in mind. The power of absorbing benzene-vapour possessed by this water depends very much on its temperature. Thus a difference of temperature of 30° F. between two meters sufficed to cause a difference in the apparent c.-p. of the gas passing through of 7 to 9·5 per cent.

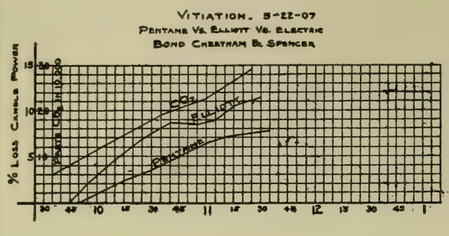


Fig 1

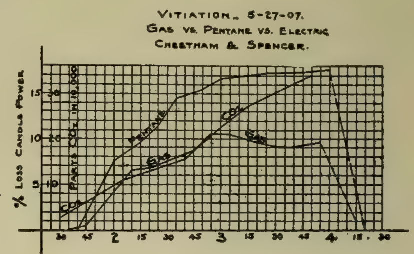


Fig 2

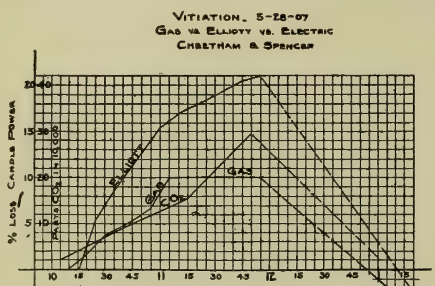


Fig 3

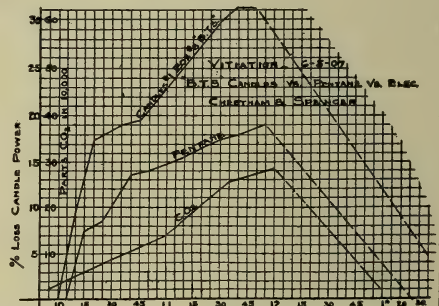


Fig 4

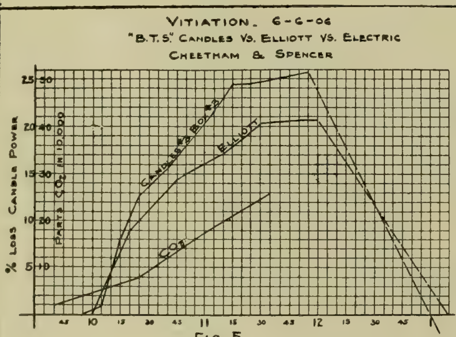


Fig 5

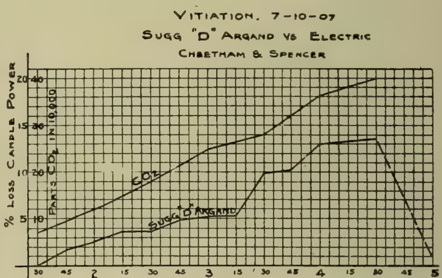


Fig 6

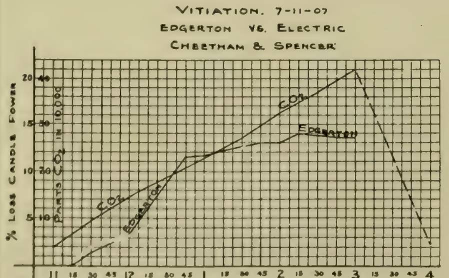


Fig 7

NOTE. Charts from 1 to 7 must not be compared with each other, because of different atmospheric conditions on different days

Report of Committee

On Methods of Taking Candle Power of Gas

American Gas Institute 1907

Appendix A. Plate IV

CORRESPONDENCE.

Need we Fear the Effects of the Ultra-Violet Constituent in the Light from Modern Illuminants on the Eye?

By Dr. W. Voege.

Drs. Schanz and Stockhausen have recently published in *The Illuminating Engineer* (vol. I. No. 12, p. 1049, 1908) a communication under the above title in which my experiments on the subject are criticized, and the results arrived at regarded as unreliable.

I have naturally no desire to enter upon the personal aspects of this matter, but feel that a justification of my contentions is needed.

In the first part of their reply these gentlemen dilate at length upon the effect of ultra-violet rays in causing Opthalmia, snow-blindness, red vision, and other physiological effects—all of which are quite accredited and were never disputed by me.

On the contrary, I have, at the very commencement of my articles, made it clear that I recognized it as an actual fact that inflammation of the eyes, burning of the skin, &c., might be experienced by investigators who exposed their unprotected eyes in the immediate neighbourhood of the arc-light; I also expressly stated, further on, that such exceptional cases would here be left out of consideration.

Now had Dr. Schanz and Dr. Stockhausen only proposed to utilize a form of spectacles, &c., capable of affording adequate protection to the eyes in these special cases, they would certainly have met with no opposition from me, and my article did not convey this suggestion. On the other hand, it *did* contest the recommendation of these gentlemen that every arc-lamp, glow-lamp, or incandescent mantle, ought to be surrounded with a globe or chimney of Euphos-glass. I also directed my criticism against their contention regarding the supposed dangerous character of such sources of light under actual practical conditions—a suggestion that is liable to arouse a considerable degree of anxiety among the general public.

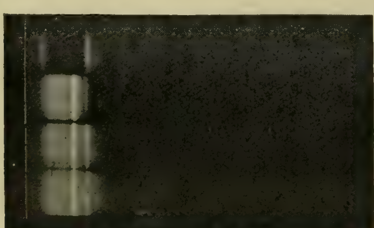
As I considered that the experiments of Drs. Schanz and Stockhausen, which failed to take into account the intrinsic brilliancy and distance away of the sources of light examined, did not serve to clear up the problem, I attempted to compare the ultra-violet light in various illuminants and in sunlight, on the basis of equal brightness of the surface illuminated. The quality of sunlight responsible for eye-troubles in those visiting mountainous districts and snow fields, and in the polar regions, does not enter into this problem; my experiments were exclusively devoted to the conditions called into play by a white or blue sky in Hamburg, and the study of a brightly illuminated surface, deriving light from the sky in this locality at 10 a.m. in July. The time of exposure, under the most favourable conditions, lasted only 5 seconds—a duration of time that certainly cannot be regarded as excessive, and is not likely to injure the normal healthy eye.

The objection that the spectral composition of daylight varies during different periods of the day and year is hard to follow. My experiments were carried out on successive days during the month of July, under a cloudless sky, and at the same time in the morning; the variation, therefore, could not have been very great. Some special experiments were also carried out under a cloudless sky with the

express object of revealing such differences as might be expected to exist. But ought we, in any case, merely because the quantity of ultra-violet light in daylight does differ somewhat, and because its examination is attended by difficulties, to abandon such comparisons entirely and adopt the recommendations of Dr. Schanz and Dr. Stockhausen without question ?

Again, optical intensity and photochemical intensity are, as these gentlemen quite correctly state, different factors, though both quantities have to be considered simultaneously. One can, however, compare the degree of ultra-violet radiation in two illuminants only by observations carried out at equal optical brightness. Such experiments as those of the authors, in which no

a
b
c
d



0·4μ 0·37μ

a. Spectrum through nitroso-solution.
b. ,, ,, Jena heavy flint glass.
c. ,, ,, Clear glass.
d. ,, ,, Unscreened.

FIG. 1.

account is taken of the differences of intensity of illumination and such varying times of exposure as four hours (through opal glass, 1mm. thick) and 5 seconds to five minutes (through Euphos - glass 0·8mm. thick), both carried out on a 10 amp. arc-lamp, are quite misleading.

It is also suggested that, by the use of the solution of nitrosodimethylaniline, I had cut off a very intense ultra-violet band in the spectrum of the arc light, which was of greater consequence than the likewise absorbed region in the spectrum of daylight. As the solution in the quartz vessel was quite unaltered in constitution and still available, I utilized it again in obtaining the quartz-spectrograph of the 3 amp. economy arc-lamp of Siemens and Halske, used on the former occasion.

As will be seen from the figure no ultra-violet band is absorbed by the solution.

The strong band near 0·4μ is still within the visible region, but the band near 0·37μ, on the other hand, is transmitted.

In order to compare especially the ultra - violet radiation of long wave-length in the case of this lamp and daylight respectively, the following experiment was carried out. A piece of sensitized paper was covered with a sheet of ordinary clear glass (which absorbs the ultra-violet radiation from 0·3μ onwards), another portion of the same paper being covered by Jena heavy flint glass. A spectrograph obtained showed that the last-mentioned glass absorbed rays from 0·366μ onwards completely. This piece of paper was also exposed to the sunlight (quite weak in December), and another similar piece to a 3 amp. arc-light at a distance of 40 m. The exposure was prolonged until, in both cases, the region of the paper not covered by the glass had become quite darkly coloured. It was then found that the difference in colouration in the portions of the paper covered by the two varieties of glass was more marked in the case of the sunlight than in the case of the arc-lamp. Since, in both cases, the visible rays were almost entirely transmitted through the glasses, and because, moreover, rays of smaller wave-lengths than 0·3μ were absorbed in each case also, the difference in colouration of the paper is to be ascribed solely to the action of the rays 0·3μ to 0·366μ. Therefore we are justified in drawing the conclusion :—

For a given photochemical intensity of the total radiation from sunlight and the arc-lamp, the rays between 0·3μ and 0·366μ have a greater relative effect in the former case than in the latter.

The next objection, that I had come to the conclusion that the spectrum of sunlight without, or even with a glass screen, extended far further into the ultra-violet than that of all artificial illuminants—which is actually not the case—is futile because I have never come to this conclusion. In this respect

the authors have failed to understand me. I have stated :—

"In this case also (*i.e.* when the spectrum of sunlight is compared with that given by a flame arc-lamp at a distance of 1m., a Regina lamp at a distance of 60m.,&c.), the solar spectrum extends further into the ultra-violet than the spectra of the artificial illuminants received on the photographic plate. The spectrum of sunlight, unscreened by glass, extends, according to my experiments, as far as 0.32μ, and the most extended spectrum of artificial illuminants only to 0.37μ."

That rays of wave-lengths as short as 0.2μ have been proved to exist in the immediate neighbourhood of the arc-light, but are wanting in sunlight in consequence of the absorption of our atmosphere, has nothing to do with the question, for these very short waves are unquestionably absorbed in the encircling glass globe. If, on the other hand, it is pointed out that in the case of two lamps, namely the Regina arc and the Quartz lamp, more ultra-violet light appears to exist, for a given intensity of illumination, than in the case of daylight, it should also be borne in mind that in the former case the outer globe, that invariably surrounds the Regina lamp under practical conditions, had been removed for the purpose of these experiments. With this outer globe on, the ultra-violet rays in the Regina lamp would be exceeded by those in the light from the blue sky. Only in the case of the Quartz lamp, where a great part of the visible rays is wanting, can it be said that the ultra-violet intensity, for a given intensity of illumination, exceeds that of daylight; even in this case, the difference is but small.

The authors are quite mistaken in supposing that my experiments were undertaken originally purely for the purpose of proving their contentions incorrect. Whatever conclusion is arrived at is based simply on the results obtained. It is to me immaterial whether lamp globes are to be made of opal-glass or Euphos-glass, and I should certainly have recommended the latter variety had my experiments led me to this conclusion.

Finally I must again differ from Dr. Schanz when he explains that this is a question that must be subjected to the investigation of oculists and not illuminating engineers. A question of this kind can never be decided solely on the recommendations of any particular profession, and I myself am far from believing that my experiments have completely settled the matter.

It is indeed, a question that is not to be lightly decided, and only concerted effort in different fields and much patient and exhaustive work can lead us to the desired goal. It is on this very ground that I regret that Dr. Schanz, whose conclusions will, moreover, not be shared by many others in his profession, should have published recommendations on this as yet undecided question, which are liable to cause widespread anxiety to the general public.

The Economical Possibilities of Lighting by Carbon Filament Lamps.

Dear Sir,—I have seen with much interest the data which your Engineering Correspondent gives on the performance of carbon filament lamps in your February number. The closeness of the points to a curve in Fig. 8 testifies to the care with which the experimental work must have been carried out. I should like, however, to point out that it does not do to draw conclusions of too general a nature.

I do not know what make of lamps was used for the tests, but a 200-hour useful life for a 3 W.p.C. 16 candle-power 100-volt lamp hardly represents good average British or American practice. The useful life for this lamp should be nearer 400 hours, a result which I know is attained as a rule by the better makers in this country. Possibly the fact that some indifferent lamps may have been used in these tests accounts

for the curve in Fig 8. differing somewhat widely from that which is generally accepted as representing average practice for low voltage carbon filament lamps. This curve (connecting watts per candle and life) which is used a good deal more in America than in this country is represented on page 296, vol. xxxviii. *Journ. Inst. Elect. Eng.* (explanation on page 299). According to this curve your correspondent's 200 hour 3·1 watts per candle lamp should have a useful life of about 880 when run at 4 watts per candle instead of the 580-hour life given by the curve in Fig. 8.

I call your attention to this, not with the object of depreciating in any way from the interest of the data given, but in order to show what a very large number of tests it is necessary to carry out on lamps of different makes in order to ensure that one's curve on which calculations of life at different efficiencies may be based, really represents average practice.

I am, dear Sir,

Yours very truly,

C. C. Paterson.

National Physical Laboratory,
February 4th, 1909.

The Editor, '*The Illuminating Engineer.*'

Dear Sir,—I read with interest the letter from Mr. C. C. Paterson, kindly submitted to me for comment previous to publication in the March issue of *The Illuminating Engineer*, regarding my investigation on 'The Economical Possibilities of Lighting by Means of Carbon Glow Lamps,' and I trust that you will be able to publish my reply in the same issue.

A misunderstanding appears to have arisen owing to the similarity of the two terms "average watts per candle" and "initial watts per candle."

In my article, the efficiency, when connected with a life test, is expressed in *average* watts per candle during the period of useful life. As explained in the text on page 26, the lighting costs are readily obtained from the product of the average watts per candle, and the price of current per unit; the result obtained being the cost per 1,000 candle hours, which is a convenient unit for purposes of comparison.

The curve, published on p. 296, vol. xxxviii. of the proceedings of the I.E.E., to which Mr. Paterson refers, shows the connexion between useful life and *initial* watts per candle, hence the apparently wide discrepancy between our respective values for useful life in terms of the efficiency.

Referring to Fig. 8 in my article, a lamp rated at 3·1 initial watts per candle, has a corresponding average efficiency of 3·45 watts per candle, the useful life, as determined from the curve in Fig. 8 being of 320 hours duration, which reasonably agrees with the value given by Mr. Paterson for a lamp rated at 3·1 initial watts per candle.

I may state that the test lamps were of a leading British make, and were selected as being representative of average quality.

I am, dear sir,

Yours very faithfully,

An Engineering Correspondent.

(E. G. K.)

The Internal Lighting of Churches.

In addition to the letter on this subject following, we have just received a communication from Mr. A. J. Marshall, of the Bureau of Illuminating Engineering, New York; with this we hope to deal in our next number.

The Internal Lighting of Churches.

Dear Sir,—I take this opportunity of making a few comments on some of the letters which appeared in the last number of *The Illuminating Engineer*, dealing with the subject of Church lighting from the point of view of architecture and religious feeling.

I am quite ready to believe that, as Mr. Stokes maintains, the architecture of many churches is such that they are best seen by daylight illumination, and not by the aid of artificial illuminants within the church as usually arranged. Therefore it may be quite right, in the case of ancient buildings, in which the architecture has presumably developed under this condition, to abstain from trying to emphasize architectural features by means of artificial lighting. On the other hand, it might be considered legitimate for the architect who designs a new building at the present day to bear in mind how vastly modern conditions have changed, and that we have now immense possibilities in the way of artificial illumination which formerly did not exist.

I need not say, however, that I appreciate the fact that care would have to be taken in utilizing artificial light in this way, and I, for one, would feel for arches outlined in naked filament glow-lamps, as great a repulsion as Mr. Stokes himself. But after all, it must be realized that, right or wrong, we are now installing modern illuminants in many churches. Though their use may be mainly for the benefit of the congregation, yet we cannot help seeing these lights ; and, if wrongly placed, they can do much to spoil the appearance of the building by night.

It is, therefore, surely reasonable for the architect to do all in his power to secure that the results are, at any rate, not in positively bad taste.

Mr. Stokes has referred to Westminster Cathedral as an example of the feeling of immensity produced by vast proportions seen by subdued light. I, in common with Mr. Stokes, naturally do not advocate such buildings being illuminated "like gin palaces."

Without wishing to be severe on the system of artificial illumination at present being installed in Westminster Cathedral, however (and it is, doubtless, purely temporary), I think it is possible that the high candle-power naked filament lamps at present being installed might fall under the category to which Mr. Stokes objects, and now modern illuminants are becoming used for lighting churches all over the country, some care will have to be exercised to prevent the installation of incongruous types of lights and fixtures.

Mr. Stokes has also explained that a church is not a theatre. During service when the attention of the audience ought by rights to be concentrated on the choir and preacher, it seems to me quite right to object to any local illumination of memorials, &c., which might distract the attention of the congregation.

On the other hand I think it must also be recognized that many churches are in a sense *museums*, in that they contain many monuments and objects of interest, and are visted quite as much for the historical associations connected with these things as they are for purely religious purposes. Therefore it is only just to recognize this fact, and to provide means of lighting these objects of interest, so that they can be seen clearly, and displayed to the best advantage, though this lighting need not, of course, be utilized while the service is in progress.

Westminster Abbey, as I have pointed out in my article, is very much more than a church. It is a national museum of a very special character, and hence ought, presumably, not to be *only* capable of being lighted as if it were exclusively a church. It is also used for great national and festive

occasions other than church-worship, which again would seem to demand a distinct method of illumination. It therefore seems to me that whatever system of lighting may be adopted, it ought to be extremely flexible, so that these different requirements can be met.

With regard to the comments of your other correspondent, Dr. B. S., I feel that his point of view, though doubtless to be borne in mind in the case of churches of a special character, is a somewhat narrow one, because it is not entirely legitimate to reason about the feelings of those in the early church, when considering the religious position of to-day.

In addition, it must be recognized that we have to consider the illumination of many different types of religious edifices, and the views on which Dr. B. S. lays stress would be only partially accepted by many of these different denominations. It is, in short, impossible to lay down any hard and fast rule from a religious standpoint in this matter, and each case of church-lighting must be considered on its merits.

I am, yours sincerely,
AN ENGINEERING CORRESPONDENT.

The Perception of Light and Colour.

By Dr. F. W. Edridge Green, F.R.C.S.

Dr. Edridge Green kindly sends us a copy of a recent publication of his in the *Berliner klin. Wochenschrift* on the above subject. Much of the article is concerned with the explanation of the author's theories of colour blindness, which he has previously dwelt upon in *The Illuminating Engineer* (vol. i. 1908, p. 807).

There are also several points of special interest respecting the physiological basis of the perception of light and colour by the "rods" and "cones" in the eye which have an interesting bearing on photometric problems. A generally accepted view of the action of these organs assigns the colour perception to the cones and the light perception *per se* to the rods. Visual purple is believed not to occur in the *fovea centralis,* where the perception of light and colour is most acute, and is therefore supposed to be not directly concerned with their recognition.

Dr. Edridge Green, however, suggests that the cones are insensitive, directly, to light, but sensitive to the chemical changes in the visual purple which light causes. Light falling on the eye causes the visual purple to retreat from the rods and spread over the other parts of the retina, including the *fovea;* in support of the latter statement he describes some experiments on the *retinæ* of monkeys which had been kept in a dark room for forty-eight hours. Visual purple was clearly seen *between* the cones in the *fovea,* though not actually in them.

The chemical change in the visual purple, the author suggests, causes a corresponding sensation stimulus, depending both in quality and quantity on the nature of the light causing it, and this stimulus is communicated to, and analyzed in a special centre in the brain. According to this theory, therefore, it is in the *brain,* and not on the retina that the sensations of light and colour are really analyzed.

The author examines critically some of the evidence in favour of the theory of the rods and cones. For instance, if total colour blindness means rod vision only, coupled with defective cones, we ought to find central scotoma in the fovea, where there are only cones. This is certainly very often the case, but not invariably so.

Dr. Edridge Green's classification of colour perception will be known to our readers. Of particular interest is the Trichromatic class, to which it is stated Sir Wm. Ramsay and Sir Joseph Thomson belong. People who have tri-, di-, or monochromatic vision should be incapacitated from occupations (such as engine driving, &c.), where colour distinction is important.

The highest stage of development recorded by the author involves the recognition of seven distinct colours, including indigo; such people have a wonderful power of memory of colour and of discriminating nice shades. A test of this latter faculty is the number of patches that can be formed in the spectrum that appear to be monochromatic. The author states that he has never encountered an individual who could distinguish more than twenty-nine.

Review of the Technical Press.

ILLUMINATION AND PHOTOMETRY.

One of the most interesting announcements of the month has been the decision arrived at by those attending a dinner held at the Criterion Restaurant in London, to form an Illuminating Engineering Society in this country. It is stated that the gathering was a very representative one, and that it was unanimously decided that the *Illuminating Engineer* should be appointed the official organ of the Society. A provisional committee was also appointed, Mr. Leon Gaster undertaking the position of Hon. Secretary. A recent number of *The Gas World* (Feb. 20th), commenting upon the matter, expresses conviction that members of the gas profession will be heartily welcomed in the Society, but also refers to the old fear that the members of the gas and electrical professions, being in active competition, cannot be brought together—we shall see.

In the literature in the United States we now observe the publication in full of several papers previously appearing in abstract in the technical journals, notably the address of **Dr. Steinmetz** before the Illuminating Engineering Society on the subject of Illumination and Illuminating Engineering. The paper contains a discussion of a number of physiological points in illumination that require further study. Dr. Steinmetz's views on the necessity for a certain degree of light and shade in the room will be found interesting. It is remarkable that it still seems to be the subject of discussion whether the eye in travelling from a brightly illuminated to a darker surface is rested or strained by so doing. At present it would seem that the correct reply is that both statements may be true. If the contrast of light and shade is very abrupt, the momentary effect on the eye is undoubtedly very trying, whatever be the exact physiological nature of the adjustment that causes discomfort. On the other hand complete uniformity is usually also felt to be disagreeable, though how far this feeling is due to the effect of these conditions on the eye and how far it is psychological is another matter. Probably what most people desire is a certain degree of play of light and shade, but with fairly gradual transition—no sharp contrasts.

Another paper now published in full in the *Transactions* of the Society is the description of the work of the Illuminating Engineering Department of the Boston Edison Company ; to this reference has previously been made.

A recent paper by **Eustice** (*Elec. Rev.*, N.Y., Feb. 6th) raises a question that is certainly a difficult one for illuminating engineers to deal with, namely, the comparison of systems of illumination *as a whole*, rather than merely in terms of the efficiency of the lamps adopted. There can be no doubt that mere photometry of lamps does not often go to the bottom of practical conditions in illumination, though, needess to state, such tests are nevertheless invaluable in their proper sphere. On the other hand it is evident how many factors there are that may affect the actual illumination achieved by an installation, which the illuminating engineer can scarcely hope to keep under his permanent control. One interesting point brought out by some of the tests of the author was the very marked effect of dust in reducing the illuminating power of fixtures. A casual inspection of the small tantalum and other lamps that one not infrequently sees crusted with dirt in the streets of London suggests that here is ample scope for the humblest illuminating engineer.

In this connexion it may be noted that a considerable number of recent communications in the United States deal more or less directly with street-lighting —**Allen** (*Elec. World,* Jan. 21st), **H. T. Owens** (*Amer. Gaslight Jour.*, Feb. 15th), and **Keleher** (*Elec. World,* Feb. 11th) all dealing with the subject. The article of Mr. H. T. Owens, dealing with the city of Boston, is of special interest, in view of the close study that the city has recently been making of these conditions, sending representatives to Europe for the purpose of studying the best methods here employed. It is mentioned that the City have now under consideration the application of automatic control to the gaslamps in the district.

GAS, OIL, AND ACETYLENE LIGHTING.

One of the most interesting communications bearing on gas-lighting during the last month was the second of the Cantor Lectures before the Society of Arts delivered by **Mr. L. Gaster,** Editor *The Illuminating Engineer,* on February 22nd.

Some account of early types of burners was given, though the development of modern efficient gas lighting may be said to begin with the introduction of incandescent mantles and the Bunsen burner. The lecturer dwelt upon the theory of both, referring to the theoretical proportions of gas and air, and describing some novelties such as the method of thermostatic control, introduced in the United States. Some types of soft mantles and other special improvements were on exhibition.

An account was also given of the different methods of high-pressure gas-lighting. The Keith and Blackman lamps of the type recently installed in Fleet Street, fitted with the new electrical ignition system, and the self-intensifying Lucas-Thermopile and Chipperfield lamps were also shown and described.

The last section of the lecture dealt mainly with methods of distance ignition, and control, examples of the Norwich and Pneumatic systems and of self-lighting mantles being shown. Reference was also made to the automatic control of street-lamps, the Bamag and Rostin and other systems being described. In conclusion, some general subjects such as the question of testing gas on a calorific basis were dealt with.

Lebies (*J.F.G.*, Feb. 6th) contributes an article on Modern High-Pressure Gas-Lighting, pointing out the necessity for intimate mixture of gas and air, remarking that the velocity of outflow of the gas must be greater than the explosion-velocity: this is accomplished by the use of high-pressure. He describes the features of the Colonie lamp. One interesting point mentioned is that consumers have to pay about 11½ per cent more for gas under pressure than for the ordinary variety, as this represents the amount which the gas is reduced in volume.

Recent numbers of the *Journal of Gas-Lighting* deal with the remarks of **Prof. Drehschmidt** in reply to the recent contribution of Dr. L. Bloch on the Public Lighting of Berlin. In an editorial the conclusion is arrived at that electricity would have to be supplied at one farthing a unit in order to compete with gas for public lighting; this is interesting in comparison with Mr. A. Voysey's result that flame-arc lamps were about four times as cheap as high pressure gas. Truly the different figures put forward on this subject require some reconciliation.

W. H. Y. Webber (*G.W.*, Feb. 13th) discusses the Gas of the Future, naturally commenting upon the matter of calorific value. The general interest in this vital question is illustrated by the extensive report of the sub-committee of the American Gas Institute on the subject (*Prog. Age.*, Feb. 15th).

Several recent articles deal with Electrical Methods of Automatic Ignition. For instance, **Wendt** describes three methods for use in lighting shop-windows, which have to comply with rigid specifications of the police in Germany.

A lecture by **W. H. Prescott** (*G.W.*, Feb. 6th) on the other hand deals with Pressure and Clockwork Controllers.

An interesting example of the manner in which gas engineers now avail themselves of electrical methods when needed is contributed by **H. Townsend** in a a paper read before the Yorkshire Junior Gas Association (*J.G.L.*, Feb. 23rd). He describes the small electric lighting plant installed at the gas-works in Wakefield in the purifying room, in order to comply with the Fire Insurance recommendations.

Among other general articles it may be noted that in the *Journal of Gas-Lighting* for Jan. 26th, on 'Gas-Lighting in the United States,' the writer discusses the work of *The Illuminating Engineer* in the United States, concluding that it is doing a full share of the work of stimulating the industry to greater perfection.

It will be noted that particulars of new patents, &c., on inverted mantles again form the subject of several articles in the German papers (*Z. f. B.*, Jan. 30th, Feb. 10th, Feb. 20th; *J.F.G.*, Feb. 6th).

ELECTRIC LIGHTING.

On February 15th a Cantor Lecture was delivered by **Mr. Leon Gaster,** Editor of *The Illuminating Engineer,* before the Royal Society of Arts, on Electric-Lighting. The lecture dealt in a general manner with the latest improvements in electric, incandescent, arc, and vapour lamps, and was accompanied by an exhibition of lamps exemplifying the latest developments. Among other lamps shown were the Duplex-Excello lamps, fitted with the new deposit-free cover, and the prismatic inner globe used for the purpose of modifying the natural curve of light-distribution so as to render the lamps more suitable for producing a uniform illumination in the streets. Other exhibits included the Crompton-Blondel and the Jandus regenerative

flame-arcs. A mercury-vapour lamp, provided with static control enabling the light to be switched on without "tipping," was also shown by the Westinghouse Co.: the kindling is accomplished by applying the momentary high-pressure resulting from the breaking of an inductive circuit across the terminals of the lamp.

Some account was also given of the conditions of the lighting industry in the United States, and of the work of the National Lamp Association, facilitating the co-operation between lamp-makers and the central stations. Stress was laid on the need for an adequate specification for metallic filament lamps.

At the conclusion some particulars were given of the Moore tube, and an experiment illustrating the effect of 5 milligrams of radium on a specimen of willemite was shown. The lecturer suggested that these methods of fluorescence and phosphorescence might eventually be made the basis of the lighting of the future.

It is again interesting to observe how the gas journals tend to devote more attention to electric matters than hitherto. For instance, the *Gas World* publishes an article by **W. A. Barnes** giving the results of some Tests on Metallic Filament Lamps under practical conditions; and the *Journal für Gasbeleuchtung, &c.*, makes a résumé of the articles on Recent Glow-Lamp Patents by Duschnitz that have recently been appearing in the *Elektrotechnischer Amzeiger.*

A considerable amount of attention continues to be devoted to the effect of the suggested Tax on Gas and Electricity on the lighting industry. Thus **Dettmar** (*E.T.Z.*, Jan. 28th) seeks to demonstrate that such a tax would handicap the lighting industry to a far greater extent than could possibly be compensated for by the slight revenue derived. It is stated in addition that the tax is unevenly designed, since the electrical industry would bear about three-quarters and the gas industry about one-quarter only.

In the technical press in the United States, as usual, the great mass of the communications deal with the Development of Tungsten Lamps, stress being laid upon their application to street-lighting. This method of illuminating streets by relatively small units placed near together seems to be gaining ground in the United States.

A reprint is now to hand of a communication by **M. F. Laporte** at the International Congress of Marseilles last year, dealing with the Specification question. The writer points out that the specifications of different countries for the carbon-filament lamps were only decided upon in time for the recommendations to be rendered ineffective by the introduction of the metallic filaments. In view of the enormous progress that is still being made in lamps of this description, however, he does not consider that the time is yet ripe for definite recommendations on this point. He also points out one defect in the existing specifications in the different countries (which are given in full in an appendix), namely, that they only become operative when comparatively large quantities of lamps change hands, and are, therefore, not much assistance to the small buyer.

Murdoch (*Elec. Rev.*, Jan. 28th) contributes a summary of some data on the Effect of Fluctuating Supply-Pressures on metallic filaments. He refers to the "overshooting" effect, and to the work of Scarpa, who has found that the behaviour of the tantalum lamp on an alternating current circuit is connected with the reaction between adjacent portions of the filament carrying a current, and therefore alternately attracting and releasing each other. This gives rise to a steady vibration of a nature which, in the case of metals akin to iron, has often been shown to be provocative of a change in crystalline condition. The low specific heat of metals and the consequent tendency of metallic filaments to expand and contract on a fluctuating P.D. makes it probable that their life is in general very seriously reduced through such fluctuations; in addition, the abnormal high value of the initial current passing through the lamp when it is first switched on and the filament is still cold, probably results in a number of lamps failing.

It may be noted that in the German papers some account is given of a Portable Ammeter for Use with Tungsten Lamps, calibrated direct in watts and provided with a special scale enabling it to be used for any pressure between 100 to 125, or, if desired, 200 and 250 volts: the apparatus seems to resemble the "Tungstometer" recently described in American papers.

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Dettmar, G. Die Steuer auf Beleuchtungsmittel für Elektricität und Gaz (*E. T. Z.*, Jan. 28).
Dick, E. Elektrische Beleuchtung von Personenwagen (*E. T. Z.*, Jan. 21).
Duschnitz, B. Metallische Leuchtfäden in der Fabrikation und in der Praxis (*J. f. G.* abstr. Feb. 13).
Editorials. A Field for Electric Streetlighting (*Elec. Rev.*, N.Y., Feb. 13).
Gaster, L. Modern Methods of Illumination (I) Electric Lighting (Cantor Lecture delivered before the Royal Society of Arts, Feb. 15).
Laporte, F. Specifications des Lampes Electriques (Congress Int. des Applications d'Electricité, 1908).
Macpherson, H. H. Some Tungsten Lamp Lessons (*Elec. World*. N.Y., Feb. 11).
Murdoch, W. H. F. Metallic Filament Lamps (*Elec. Rev.*, Jan. 28).
Schroeder, H. Series Tungsten Lamp Lighting (*Elec. World*, Feb. 4).
Der Entwurf des Elekricitätssteuergesetzes in technischer Beleuchtung (*Elek. Anz.*, Jan. 21).
Diagram-Wattmeter (Glühlampenprüfer) (*Elek. Anz.*, Jan. 28, Feb. 21).
Renewing Incandescent Lamps (*Elec. World*, N.Y., Feb. 4).
The Chicago Electrical Show (*Elec. Rev.*, N.Y., Jan. 23).
Street Illumination (*Elec. World*, Jan. 21, Jan. 28).

GAS, OIL, AND ACETYLENE LIGHTING, &c.

Brandt, O. Neuer Glühkorper für Hangegasglühlicht (*J. f. G.*, Feb. 6).
Drehschmidt, Prof. H. Recent Advances in Streetlighting in Berlin (*J. G. L.*, Jan. 26, Feb. 2, from the *J. F. G.*)
Editorials. Flame Arcs *v.* High Pressure Gaslighting (*J. G. L.*, Feb. 9).
Hygienic Advantage of Gas over Electric Lighting (*J. G. L.*, Feb. 16).
Gaslighting in the United States (*J. G. L.*, Jan. 26).
Gaster, L. Modern Methods of Illumination (II) Gaslighting (Cantor Lecture before the Royal Society of Arts, Feb. 22).
Gatehouse, J. W. The Impurities in Acetylene (*Acetylene*, Feb.).
Protais, L. L'Affaire Buisson Hella (*Rev des Eclairages*, Feb. 15).
Prescott H. W. Pressure and Clockwork Controllers (*G. W.*, Feb. 6).
Lebeis. Ueber moderne Pressbeleuchtung (*J. f. G.*, Feb. 6).
Little, T. J. Competition from High Efficiency Lamps (*Am. Gaslight Jour.*, Jan. 25).
Stinson, W. J. Acetylene Town Lighting (*Acetylene Jour.*, Jan.)
Townsend, H. A Small Electric Lighting Plant at Wakefield (*J. G. L.*, Feb. 23).
Webber, W. H. Y. The Gas of the Future (*G. W.*, Feb. 13).
Wendt, Elektrische Gasfernzünder und Ihre Zulassung bei Anlage von Gasbeleuchtung in Schaufenstern (*J. f. G.*, Jan. 30).
The Grätzin High Pressure Inverted Lamps (*J. G. L.*, Feb. 16).
Neue Invertbrenner (*Z. f. B.*, Jan. 30, Feb. 10, Feb. 20).
Die Besteuerung des Beleuchtungsmittel (*Z. f. B.*, Feb. 10).

MISCELLANEOUS.

Allen, F. Some Phenomena of Persistence of Vision (*Phys. Rev.*, Jan.).

CONTRACTIONS USED.

E. T. Z.—*Elektrotechnische Zeitschrift.*
Elek. Anz.—*Elektrotechnischer Anzeiger.*
G. W.—*Gas World.*
Illum. Eng., N.Y.—*Illuminating Engineer of New York.*
J. G. L.—*Journal of Gaslighting.*
J. f. G.—*Journal für Gasbeleuchtung und Wasserversorgung.*
Prog. Age.—*Progressive Age.*
Phys. Rev.—*Physical Review.*
T. I. E. S.—Transactions of the Illuminating Engineering Society.
Z. f. B.—*Zeitschrift für Beleuchtungswesen.*

PATENT LIST.

COMPLETE SPECIFICATIONS ACCEPTED OR OPEN TO PUBLIC INSPECTION.

I.—ELECTRIC LIGHTING.

1,596. Arc lamps Jan. 23, 1908. Accepted Jan. 27, 1909. H. E. Moul, 18, Kensington Court Place, London.

2,707. Incandescent lamps. Feb. 6, 1908. Accepted Jan. 27, 1909. J. Howard, 70, Chancery Lane London.

3,388. Incandescent lamps (C.S.). I.C. Aug. 7, 1907, U.S.A. Accepted Feb. 17, 1909. J. W. Howell, 83, Cannon Street, London.

4,977. Arc lamps. Mar. 5, 1908. Accepted Feb. 10, 1909. A. D. Jones, Hartham Works, Hartham Road, Holloway, London.

6,471. Indicating extinguishing of lamps. Mar. 23, 1908. Accepted Feb. 3, 1909. S. Mundey, 31, Bedford Street, Strand, London.

10,590. Incandescent lamp filaments. May 15, 1908. Accepted Feb. 10, 1909. The British Thomson-Houston Co., Ltd., 83, Cannon Street, London. (From General Electric Co., U.S.A.)

10,696. Lenses for electric lamps. May 16 1908. Accepted Jan. 27, 1909. J. S. Burns and The Sylverlyte Electric Lamp Co., Ltd., 173, Fleet Street, London.

12,592. Push-switch lamp-holder. June 12, 1908. Accepted Feb. 17, 1909. G. H. Ide, 152, Sherlock Street, Birmingham.

13,100. Arc lamps (C.S.). June 19, 1908. Accepted Jan. 27, 1909. H. Miertschke, 65, Chancery Lane, London.

14,982. Arc lamp with inclined carbons (C.S.). July 15, 1908. Accepted Feb. 3, 1909. Verity's Ltd., and F. S. Worsley, 11, Burlington Chambers, New Street, Birmingham.

17,421. Arc lamps (C.S). I.C. Aug. 20, 1907. Accepted Jan. 27, 1909. Körting & Matheson Akt.-Ges., 24, Southampton Buildings, London.

18,233. System of fitting incandescent lamps (C S.). I.C. Jan. 10, 1908, France. G. Weissmann, 20, High Holborn, London.

19,052. Supports for lamp filaments (C.S.). Sept. 10. 1908. Accepted Jan. 27, 1909. F, R. Pope and M. W. O'Connell, 322, High Holborn, London.

19,659. Filaments for incandescent lamps (C.S.). Sept. 18, 1908. Accepted Jan. 27, 1909. W. P. Thompson, 6, Lord Street, Liverpool. (From O. Inwald and R. von Inwald, Austria.)

II.—GAS LIGHTING.

1,453. Gas burners, and electrical devices for controlling from a distance. Jan. 21, 1908. Accepted Jan. 27, 1909. H. L. Down and Telephos, Ltd., 115, Cannon Street, London.

2,604. High pressure lighting and heating relief valve boxes. Feb. 5, 1908. Accepted Feb. 3. 1909. T. Glover, 173, Fleet Street, London.

2,688. Controlling devices for inverted incandescent burners. Feb. 6, 1908. Accepted Feb. 17, 1909. E. Hinton and F. A. Andrews, 3A, Hall Place, Paddington, London.

2,800. Inverted incandescent burners. Feb. 7, 1908. Accepted Feb. 10, 1909. A. S. Francis, 77, Chancery Lane, London.

2,960. Lanterns. Feb. 10, 1908. Accepted Jan. 27, 1909. J. Gunning, Birkbeck Bank Chambers, London.

4,073. Pressure regulators for gas burners. Feb. 24, 1908. Accepted Jan. 27, 1909. C. C. Broad, 24. Temple Row, Birmingham.

4,885. Electrically controlled gas-lighting devices. March 4, 1908. Accepted Feb. 10, 1909. J. C. A. Maddick, 34, Castle Street. Liverpool.

5,626. Incandescent burners. March 13, 1908. Accepted Jan. 27, 1909. H. Darwin, 24, Temple Row, Birmingham.

10,613. Fittings of inverted incandescent lamps. May 15. 1908. Accepted Jan. 27, 1909. J. Webber, 18, Southampton Buildings, London.

14,592. Automatic cut-off for gas-cocks. July 9, 1908. Accepted Jan. 27, 1909. G. Booth, 166, Westminster Bridge Road, London.

16,979. Support for gas-lanterns (C.S.). Aug. 12, 1908. Accepted Feb. 3, 1909. J. Gunning, Birkbeck Bank Chambers, London. (Additional to 2960/08.)

17,675. Reflector for inverted gas light (C.S.). Aug. 22, 1908. Accepted Feb. 3, 1909. E. Hindrichs, 345, St. John's Street, London.

19,723. Incandescent lamps (C.S.). Sept. 19, 1908. Accepted Feb. 17, 1909. S. Chandler and J. Chandler, Birkbeck Bank Chambers, London.

20,004. Lanterns (C.S.). Sept. 23. 1908. Accepted Feb. 10, 1909. J. Gunning, Birkbeck Bank Chambers, London. (Addition to 2960/08.)

20,465. Inverted incandescent burners (C.S.). Sept. 29, 1908. Accepted Feb. 17, 1909. C. W. Bland, 33, Cannon Street, London.

1,531/09. Incandescent lamps (C.S.). I.C. Jan. 21. 1908, France. G. Bourrelly, 24, Southampton Buildings, London.

2,292/09. Liquid illuminating gas (C.S.). I.C. Jan. 31, 1908, Germany. H. Blau, 31, Bedford Street Strand, London.

III.—MISCELLANEOUS

(including lighting by unspecified means, and inventions of general applicability).

20,746. Condensing globe or lamp-shade (C.S.). I.C. Oct. 3, 1907, Belgium. Accepted Jan. 27, 1909. B. Bronislawski, 24, Temple Row, Birmingham.

22,235. Glass carrier for inverted incandescent gas or oil lamps (C.S.). Oct. 20, 1908. Accepted Jan. 27, 1909. A. G. Bloxam, Birkbeck Bank Chambers, London. (From Sparlicht G.m.b.H. Germany.)

28,435. Incandescent gas and electric filaments (C.S.). I.C. Jan. 10, 1908, Switzerland. R. Laigle, 18, Southampton Buildings, London.

EXPLANATORY NOTES.

(C.S.) Application accompanied by a Complete Specification.

(I.C.) Date applied for under the International Convention, being the date of application in the country mentioned.

(D.A.) Divided application: date applied for under Rule 13.

Accepted.—Date of advertisement of acceptance.

In the case of inventions communicated from abroad, the name of the communicator is given after that of the applicant.

Printed copies of accepted Specifications may be obtained at the Patent Office, price 8*d*.

Specifications filed under the International Convention may be inspected at the Patent Office at the expiration of twelve months from the date applied for, whether accepted or not, on payment of the prescribed fee of 1s.

N.B.—The titles are abbreviated. This list is not exhaustive, but comprises those Patents which appear to be most closely connected with illumination.

It is with great regret that we chronicle the death of Mr. W. W. Strode, of the firm of Messrs. Strode & Co., who are prominently connected with several systems of lighting, on January 30th. We understand that the business will in future be under the supervision and direction of his sons, Mr. D. W. and Mr. G. W. Strode, who have been associated with their father in the management for the last seven years.

Publications Received.

We have received a copy of *Electric Lamps*, by Maurice Solomon, a general and up-to-date treatise on modern commercial types of electric illuminants and methods of testing them. To this volume we hope to refer in detail shortly. The book is published by Messrs. Constable & Co. (6*s*. net).

Annual Prize Distribution of the Northampton Institute, Clerkenwell, London, E.C.

The annual prize distribution and Conversazione of the Northampton Institute was held on February 5th and 6th, when the prizes were distributed by the Right Hon. the Earl of Halsbury.

Subsequently a short lecture was delivered by Dr. C. V. Drysdale on 'Electrical Oscillations,' and the laboratories were open to inspection, interesting examples of photometrical apparatus, including an example of the globe-photometer, being exhibited. Some interesting spectroscopic apparatus was also on view, and an ingenious method of projecting and mixing spectral colours was exhibited by Messrs. Newton.

TRADE NOTES.

On p. 172 will be found an account of the chief exhibits at the two Cantor Lectures delivered by the Editor before the Royal Society of Arts on February 15th and 22nd.

In addition we have to acknowledge with thanks the receipt of much information relating to the systems of lighting with which these firms are connected.

The ILLUMINATING ENGINEER

ELECTRICITY · ACETYLENE · OIL · GAS

Edited by LEON GASTER

THE JOURNAL OF SCIENTIFIC ILLUMINATION.

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EDITORIAL.

Illuminants and Illuminating Engineering.

WE observe in our esteemed contemporary, the *Journal of Gas Lighting*, an article under the above title, in which the aims of the Illuminating Engineering Society, and the results achieved by our American predecessors in this field during the first three years they have been in existence, are the subject of discussion.

It need not be said that we are pleased to observe this gratifying illustration of the importance now attached to the subject of illuminating engineering, and welcome this support.

While congratulating the American Society on the excellent work they have done, our contemporary appears to think that their progress in the aims of the illuminating engineering has been relatively slow. For our part, having been perhaps, in a somewhat better position to trace the gradual evolution of the movement, we are quite satisfied that matters have taken shape much more rapidly than even we expected, both in this country and in the United States. In forming a society and creating a journal devoted solely to the consideration of illuminating engineering, we have obtained the first great requisite for the development of the expert illuminating engineer, namely, a free and impartial platform. The development of such an expert must be very gradual. It is quite true and natural, that many of the papers presented to the Illuminating Engineering Society have been written about gas or electricity by engineers connected with their respective systems of lighting, but this was to be expected and was, indeed, desirable.

But such papers differ radically from those of a purely partisan character such as would often be read by an engineer connected with one system of lighting before an audience representing his trade. At the Illuminating Engineering Society, the audience is representative of all the trades and professions interested, and therefore of a critical spirit. Any paper presented to them must be moderate in tone, and the reader must only put forward statements which he can justify. In our experience moderation and genuine desire for information have been characteristic of papers read before the Society in the United States. And to the majority of those interested in lighting, it is no small matter to be able to read, in the same transactions, papers dealing with all systems of lighting written by experts in their particular fields.

Again, it must be recognized that a man in the front of his profession, and identified with a particular illuminant, cannot be expected abruptly to modify his course of work even though his point of view be enlarged and his sympathies widened; self-interest and business connexions alone render it difficult for him to assume immediately the impartial attitude of the ideal illuminating engineer. It is therefore to the younger generation, who are growing up in this new atmosphere of toleration, that we must look mainly for the specialist of the future.

The General Interest in Illumination.

It is perfectly true that in many cases, as we have frequently pointed out, flame arcs and high-pressure gas lamps are still used by some shopkeepers with an utter disregard for their own interest and the convenience of the public; our contemporary, therefore, is so far correct in presenting shop-lighting as an illustration of popular lack of progress, but we believe that once the matter is properly put before them, shop-keepers are eager and willing to learn in this respect.

Until contractors and lighting engineers themselves devote more attention to the subject of proper illumination of shop-windows, it can hardly be expected that the ordinary shop-keeper will do so. The progress in the last year shows, however, that the better class of shops now recognize that it is wise as a matter of principle, to illuminate their goods rather than the eyes of the customers; in this connexion it is gratifying to observe that the illumination of windows has been made a special point of attraction at the new installation of Selfridge's, and that this feature has been the subject of special comment in the technical and daily press.

In the same way we think that it is quite unreasonable to expect even such a successful and energetic body as the Illuminating Engineering Society in the United States, to have accomplished more in their short period of existence than they have already done as regards stimulating the general public to appreciate good illumination.

In any new movement the first essential is to create a band of enthusiasts with the necessary knowledge and sympathies, who will in turn influence the general public. It was with this object in view that the *Illuminating Engineer* was designed to appeal to those who would eventually act as these leaders. The contents of the magazine have therefore been kept up to a high scientific standard, and but little attempt has been made as yet to appeal directly to the man in the street. The man in the street, however, requires guidance on these matters; what is wanted therefore, is a force of reliable advisers by whose help he might benefit.

In every movement we can see the same attitude being taken up by the general public. It is not enough merely to enquire, "when doctors differ who shall decide?" In such cases it is essentially our duty to find

out the reason for such disagreement. If it can be traced to the misunderstandings of certain scientific principles, it is clearly our business to investigate the matter, and, after having come to closer agreement, then to act as guides to the general public.

On the other hand we must confess that there seems to us of late to have been a remarkable growth of appreciation of proper illumination on the part of the general public. The multiplication of articles dealing with lighting in the daily press, partisan as many of them undoubtedly are, illustrates this tendency. The large audience present at each of the series of the four Cantor Lectures just delivered before the Royal Society of Arts should also serve as an indication of the keenness with which these matters are now being studied.

We think too, that no one who has followed the general tone of discussions on the merits of gas and electricity &c., can doubt the development of a new spirit of toleration. We venture to think that the support given to the writer by the various trades representing different systems of lighting, in connexion with the Cantor Lectures mentioned, remarkable even to day, would have been impossible but a few years ago, and may, therefore, rightly be attributed to a recognition of the value of our aims and endeavours in connexion with illuminating engineering.

We have recently had another marked illustration of the change in attitude, in the announcement of the sub-committee of the International Elektrotechnical Commission, appointed to deal with the International Standard of Light, on which both gas and electrical representative are working in harmony. The same journals, which, but a few years ago, prophesied the impossibility of getting gas and electrical engineers to work together, now observe with gratification that "electrical and gas interests are to be amalgamated for the common good."

In conclusion we think it well to point out that so many of the predictions of our friendly critics have now been falsified, that some caution might be exercised by them in the future. If a certain result is admitted to be desirable, why hinder its realization by magnifying such difficulties as, in their opinions, exist? Surely it is not wise to assume, that because certain admittedly mistaken views are prevalent in some quarters at the present time, this will always be the case. Far better is it for all of us to fix our minds on the conditions which we feel sure to be desirable, firm in the conviction that ignorance and prejudice must eventually give way to the light of commonsense and reason; we ourselves, welcome their co-operation in the task of realizing conditions which we both consider desirable.

Illumination and Visual Acuity.

The contributions of Prof. S. W. Ashe and Mr. J. S. Dow on this subject certainly bring forward a number of interesting debatable points, and it may be noted that these observers seem to differ not only from one another, but also from MM. Laporte and Broca, whose interesting work was referred to in the first volume of *The Illuminating Engineer* (November, 1908, p. 947). According to Mr. Dow the conclusions arrived at by earlier workers in this field seem, at first sight, to be likewise very contradictory.

The question of the quality of light best adapted to *reveal detail* as apart from the *creation of brightness* is one of some importance because so much of the illumination produced is used for the former end alone. It may be said, for instance, that a very large proportion of the artificial light generated is utilized simply to enable people to read and write. W use our eyes to such an extent now days that any possibility of improving the ease and comfort of reading and writing would be hailed with satisfaction. At the same time it ought to be recognized that even were it proved that light of a certain wave length was best

of all for detail-revelation it does not follow that we should be justified in trying to read and write by this quality of light alone. One would, indeed, discourage the incautious continuous use of any quality of light of very unusual character on general physiological grounds; probably therefore the uses of monochromatic light must always be restricted.

The relative value of different portions of the spectrum for detail revealing purposes must be considered a very debatable matter. MM. Laporte and Broca found that there was no appreciable difference between the ordinary artificial illuminants from this point of view. Prof. Ashe finds that visual acuity is greatest in the blue region of the spectrum. Mr. Dow suggests that the blue end is somewhat better in the case of near vision, while the red end is preferable at a distance, though even this conclusion is qualified.

The question is, of course, essentially a physiological one. The matter has been studied hitherto almost invariably either by those interested in the photometrical and engineering sides of the question, or by those who were purely physiologists. There is indeed, a vast amount of valuable physiological work on record, on which the illuminating engineer ought to be informed, but which unfortunately, not infrequently proves on close examination to be unsatisfactory for his needs because some very vital detail — from his standpoint — is omitted. On the other hand the more perfect knowledge of the physiologist of his own side of the question sometimes leads him to condemn the work of the engineer, because he realizes that the latter has ignored some physiological effect which may entirely obscure the real question at issue.

The only conclusion to be drawn is that problems of this nature can only be really adequately solved by concerted effort between those connected with both aspects.

Meantime, recognizing the complexity of such problems, we must also admit the possibility of individual researches, apparently leading to quite different conclusions, being in reality quite reconcilable with each other when the exact conditions under which they were made are borne in mind.

The International Unit of Light.

It will be observed that a short note appears elsewhere regarding the sub-committee appointed by the International Electrotechnical Commission to deal with the question of the international unit of light.

It will be remembered that a proposal was submitted by the French delegates at the meeting of the Commission last year, according to which the units employed in France, Great Britain, and the United States were to be brought into practical equality. This suggestion received general approval as regards principle. The announcement from the National Physical Laboratory regarding the result of using the Assmann hygrometer instead of the old wet and dry bulb type of instrument, however, led to the international relations between the standards being reconsidered, and the matter was put in the hands of a sub-committee for future consideration; it was also decided that arrangements should be made in each country to secure the co-operation on this committee of those connected with different systems of lighting.

We are glad to observe that the assistance of representatives of the gas industry has now been secured by the Committee; we hope and believe that this co-operation will lead to satisfactory results in this case and will form a precedent for further mutual assistance in the future. We are given to understand that important announcements on the subject of the international unit of light are to be made shortly. Any simplification in this direction will certainly be hailed with gratitude and relief by the countries concerned. LEON GASTER.

Review of Contents of this Issue.

Mr. A. P. Trotter (p. 223) on this occasion deals with the question of Photometer Scales and the calibration of photometric benches direct in candle-power. He refers to the type of scale used in connexion with the method of moving only one of the sources, and keeping the photometer stationary, as employed by the Gas Referees, and gives a table for use with a bench using a movable photometer.

Dr. C. R. Boehm (p. 227) commences some notes dealing with Incandescent Gas Lighting. In the present number he quotes some details of the mantle industry in Germany, and considers the several qualities of the ordinary cotton and Ramie mantles,

Dr. C. V. Drysdale (p. 230) continues his discussion of The Laws and Measurement of Radiation. In the present instalment he explains the nature of Wien's law, and presents a series of curves exhibiting the quality of radiation from a black body at different temperatures, as obtained by Lummer and Pringsheim. These curves enable us to trace the effect of temperature on the luminous efficiency of an incandescent solid illuminant approximating to a black body.

Mr. J. S. Dow (p. 233) describes some investigations on the Detail-Revealing Power of Different Qualities of Light. It has been suggested that "visual acuity" might be made the basis of a convenient form of photometer for use in comparing illuminants which differ markedly in colour. The author, however, points out that visual acuity is very dependent on accommodation, and would lead to quite different results according to the distance of the eye. For this and other reasons he suggests that visual acuity tests cannot be substituted for those carried out on the ordinary "equality of brightness" principle.

The same subject is dealt with in an article by **Prof. S. W. Ashe** (p. 275), who, however, finds that light from the blue end of the spectrum is most favourable to visual acuity. He also describes some experiments on the effect of bright sources in the field of view in causing contraction of the pupil-orifice, which, he states, may reduce visual acuity by as much as 30 per cent.

A paper by **Dr. E. P. Hyde**, and other collaborators (p. 241), treats of the selective Emission of Lamp Filaments, and describes some recent methods of investigating these qualities, and determining whether a body exhibits "selective radiation" or no. This contribution is to be continued in a subsequent number.

The second and third Cantor Lectures on Modern Methods of Illumination, delivered by **Mr. Leon Gaster**, the editor of this journal, before the Royal Society of Arts on February 22nd and March 1st of this year, are abstracted in this number (pp. 244–271).

The first of these deals in a general manner with Modern Gas Lighting. The development of the early burners and the incandescent mantle is sketched, reference being made to some of the most recent examples exhibited at the lecture. The subject of high-pressure gas lighting, and the use of self-contained pressure lamps is also dealt with, and a short résumé is given of methods of automatic ignition.

These include methods merely utilizing the actual gas pressure by the aid of a special switch, pneumatic systems, self-lighting devices, and electrical methods. The application, to public lighting of devices utilizing clockwork and temporary waves of gas pressure is also discussed.

Finally some remarks are made on matters of general interest from the point of view of illuminating engineering.

It is pointed out, for instance, how the possibility of ultimately replacing tests of illuminating power of gas by those giving information as regards its calorific value, is now receiving attention. The more friendly attitude of gas companies towards consumers,

is also characteristic of the progress recently made by the gas industry.

The second lecture deals with PORTABLE AND SELF-CONTAINED SYSTEMS OF LIGHTING, such as oil, petrol-air, and acetylene, &c. Descriptions are given of ordinary petroleum and incandescent oil lamps, and the advantages and drawbacks of petrol-air lighting are discussed. A general survey is taken of recent progress in acetylene, and several ingenious automatic devices to facilitate the use of dissolved acetylene in connexion with beacons and buoys are described. In conclusion the comparative running costs of different illuminants are referred to, and a summary is given of some of the scientific principles underlying the theory of light production.

An Engineering Correspondent (Dr. B. S.) contributes some further data regarding the historical development of street lighting in London, showing how the lighting of public places came to be gradually taken out of the hands of individual householders and placed under the control of municipal authorities (p. 272).

Among other articles in this number mention may be made of that summarizing the experiences of Dr. Bellile, a French physician, regarding the EYE TROUBLE EXPERIENCED BY WIRELESS TELEGRAPHY OPERATORS, which are ascribed to the action of the ultraviolet light from the spark used with the transmitter. It is suggested, however, that the actual electro-magnetic waves themselves may also exert a prejudicial influence on the human organism (p. 278).

A recent report, presented to the Conseil d'Hygiene de la Seine, deals with the subject of FACTORY LIGHTING (p. 229). No definite regulations are suggested as yet, but advice is given on several points, notably as regards the placing of sources outside the field of view of work-people, and the use of walls and ceilings of a light tint, so as to facilitate the diffusion of light; it is also recommended that light yellow tints should be employed, as these help to absorb radiation of short wave-length that may be objectionable.

In addition it is pointed out that workshops illuminated only by artificial means usually suffer both through a tendency to vitiation of the atmosphere, and also owing to indirect consequences of prolonged exclusion of sunlight.

A communication is published regarding the constitution of a sub-committee of the International Electrotechnical Commission appointed to consider the question of the INTERNATIONAL UNIT OF LIGHT (p. 226). This committee includes among its members representatives both of the gas and electrical interests.

It is stated that the suggestion of the French delegates regarding the establishment of a common unit of light in Great Britain, France, and the United States is being carefully considered and important decisions are expected shortly.

Some account is also given of the work and photometrical equipment at the NATIONAL PHYSICAL LABORATORY.

The correspondence columns (p. 279) include communications from **Mr. A. J. Marshall** and an Engineering Correspondent (Dr. B. S.) on the LIGHTING OF CHURCHES.

The former advocates co-operation between the architect and the lighting engineer, and maintains that the *true* "illuminating engineer" must have a lively appreciation of artistic principles.

The latter quotes some more instances in support of his contention that religious buildings demand a subdued illumination.

This he claims, is illustrated by the conditions prevailing in the Temple at Jerusalem, and at Lhasa in Thibet, and indeed, in most religious buildings of old origin.

Mr. Maurice Solomon (p. 281) discusses the TESTS OF CARBON FILAMENTS GLOW-LAMPS recently published by E. G. K. in this journal, suggesting that the latter are not representative of the best modern types of lamps.

He also refers to one possible source of uncertainty in the standard specification.

At the end of this journal will be found the usual **Review of the Technical Press** (p. 283) and the **Patent List** (p. 288).

TECHNICAL SECTION.

[*The Editor, while not soliciting contributions, is willing to consider the publication of original articles submitted to him, or letters intended for inclusion in the correspondence columns of 'The Illuminating Engineer.'*

The Editor does not necessarily identify himself with the opinions expressed by his contributors.]

Illumination, Its Distribution and Measurement.

By A. P. Trotter,

Electrical Adviser to the Board of Trade.

(*Continued from p.* 153.)

Photometer Scales.

Having now described a few different kinds of photometers, attention may be paid to an important accessory of all such instruments, namely the scale. It is customary in educational laboratories to provide nothing but simple scales of centimetres or inches, in order that the students may have to calculate their results. For ordinary work, direct reading scales are always used, and these, though based on the law of squares (see page 96), can be arranged in several different ways. In using a photometer of the Rumford or Foucault type, such as the Harcourt photometer of the Metropolitan Gas Referees, the scale is simply a scale of squares. One lamp is fixed, and the other is moved. The standard is generally fixed. Count Rumford says that his standard lamp was "always placed exactly opposite to that division of the scale which is marked 100....This division is of course at the distance 31·62 inches from the middle of the field of the instrument" (that is to say, his screen) "that marked 10 degrees being at a distance of 10 inches." The only change that need be made for modern work is to alter a decimal place and to set the standard at 10 if a 10 candle standard is used. The scale is therefore graduated as in Fig. 65, where L is the far end of the scale, and S is the end next to the screen. The scale AB is a uniformly divided scale, to show the relation. But it is not convenient, in the case of the Foucault photometer, to attach an index to the lamp itself. A long rod is used, easily accessible to the observer, who sits behind the screen. The lamp is moved by pushing or pulling this rod. The scale may be fixed on the table, and an index carried on the rod, as shown in Fig. 65,

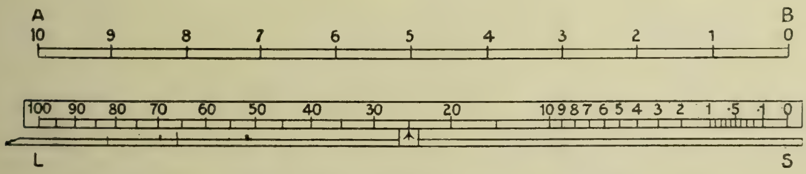


Fig. 65.—Photometer scale fixed to the table, pointer fixed to the rod.

or the index may be attached to the table, and the scale may be carried on the rod, as in Fig. 66. In this case the scale is reversed. The latter is generally the best arrangement, for the index is always in the same position, and can be arranged where it is most convenient.

In the case of the Bunsen photometer, as generally used, the two lamps are fixed, and the photometer head moves between them. The middle of the scale is marked 1, being the ratio of the candle-powers. The total length of the scale is generally 100 inches (254 cm.) or 60 inches (152·4 cm.) or 2 metres (78·74 inches). The graduations are not carried to the ends, as large ratios are difficult to measure. With a 100-inch bar, and a 16 candle-power lamp at each end, the photometer at the mid-point receives an illumination of about one foot-candle. This is a good illumination for most photometers. With too bright or too feeble an illumination high accuracy cannot be obtained, but the practical range is very large. When one lamp A (Fig. 67) is of 16 candle-power, and the other B is 4 candle-power, the photometer head

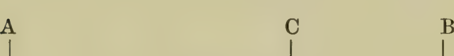


Fig. 67.

C is at such a position that AC is twice BC. If BA is 100 inches, AC is $66\frac{2}{3}$ inches, and BC is $33\frac{1}{3}$ inches. The scale may be calculated from the formula

$$l = \frac{1}{1+\sqrt{n}}$$

where l is a length measured on the bar, and is proportional to the light to be measured. This cannot be set directly on a slide rule. The best way of calculating the scale is by the use of a table of square roots and a table of reciprocals. For example, to find on a 100 inch scale, the graduation representing the ratio 2·5, look out the square root of 250, and find 15·811. The square root of 2·5 is, therefore, 1·5811. Add 1, and look out the reciprocal of 2581. This is

Scale for a photometer bar with a fixed source of light at each end, and a movable photometer head.

Total length, 100 units.

Graduation No. or Ratio.	Length.	Graduation No. or Ratio.	Length.	Graduation No. or Ratio.	Length.
50	12·39	4·6	31·80	1·1	48·81
40	13·65	4·4	32·28	1·08	49·04
30	15·44	4·2	32·79	1·06	49·27
25	16·67	4	33·33	1·04	49·51
24	16·95	3·9	33·62	1·02	49·75
23	17·26	3·8	33·90	1	50
22	17·57	3·7	34·20	0·98	50·26
21	17·91	3·6	34·51	0·96	50·51
20	18·27	3·5	34·83	0·94	50·77
19·5	18·47	3·4	35·16	0·92	51·04
19	18·66	3·3	35·50	0·9	51·31
18·5	18·86	3·2	35·86	0·88	51·60
18	19·07	3·1	36·22	0·86	51·88
17·5	19·29	3	36·60	0·84	52·18
17	19·52	2·9	37	0·82	52·48
16 5	19·75	2·8	37·41	0·8	52·79
16	20	2·7	37·83	0·78	53·10
15·5	20·26	2·6	38·28	0·76	53·42
15	20·52	2·5	38·75	0·74	53·76
14·5	20·80	2·45	38·98	0·72	54·10
14	21·09	2·4	39·23	0·7	54·44
13·5	21·39	2·35	39·48	0·68	54
13	21·72	2·3	39·73	0·66	55·17
12·5	22·05	2·25	40	0·64	55·56
12	22·40	2·2	40·27	0·62	55·95
11·5	22·77	2·15	40·55	0·6	56·35
11	23·17	2·1	40·83	0·58	56·77
10·5	23·59	2·05	41·02	0·56	57·20
10	24·03	2	41·42	0·54	57·64
9·8	24·21	1·95	41·73	0·52	58·10
9·6	24·40	1·9	42·04	0·5	58·58
9·4	24·60	1·85	42·37	0·48	59·07
9·2	24·79	1·8	42·71	0·46	59·59
9	25	1·75	43·05	0·44	60·12
8·8	25·21	1·7	43·41	0·42	60·68
8·6	25·43	1·65	43·77	0·4	61·25
8·4	25·65	1·6	44·15	0·38	61·86
8·2	25·88	1·55	44·55	0 36	62·50
8	26·12	1·5	44·95	0·34	63·17
7·8	26·37	1·45	45·37	0·32	63·87
7·6	26·62	1·4	45·81	0·3	64·61
7·4	26·88	1·38	45·97	0·28	65·39
7·2	27·15	1·36	46·16	0·26	66·23
7	27·43	1·34	46.35	0·24	67·12
6·8	27·72	1·32	46·54	0·22	68·07
6·6	28·02	1·3	46·72	0·2	69·10
6·4	28·33	1·28	46·92	0·18	70·21
6·2	28·65	1·26	47·11	0·16	71·43
6	28·99	1·24	47·31	0·14	72·77
5·8	29·34	1·22	47·52	0·12	74·27
5·6	29·70	1·2	47·72	0·1	75·98
5·4	30·09	1·18	47·93	0·08	77·95
5·2	30·48	1·16	48·15	0·06	80·32
5	30·90	1·14	48·36	0·04	83·33
4·8	31·34	1·12	48·58	0·02	87·61

given as 3874467. This means, say, 38·75 inches from the end. The decimal places are rather confusing. On the opposite page is a table for a scale 100 units long, and Fig. 68 gives an idea of the general appearance of such a scale.

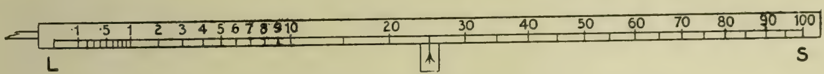


FIG. 66.—Scale fixed to the rod, index fixed to the table.

Fig. 69 is a portion of the middle of such a scale, full size. It is not difficult to adjust to 2 per cent, but it is not worth while to graduate the scale to less than 1 per cent, for though under favourable conditions readings may be repeated to 1 per cent, and from a mean of a number of such readings a result may be given to half of 1 per cent, such measurements are of the nature of guesswork, and the intermediate position of the index may be estimated more accurately than its true position can be found.

While this form of scale is very useful for general photometric work, since it is independent of the actual candle-power of the lights, and deals with ratios, it is not a direct reading scale, unless the standard lamp is of 1, 10, or 100 candle-power. A scale 100 inches long is much too long for comparing lights of about 1 candle-power, and too short for lights of about 100 candle-power. If a 1 candle and a 10 candle-power lamp be compared on such a scale, the illumination at the photometer is about a quarter of a foot-candle.

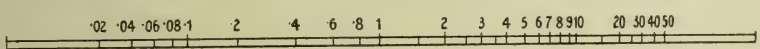


FIG. 68.—The Ratio Scale.

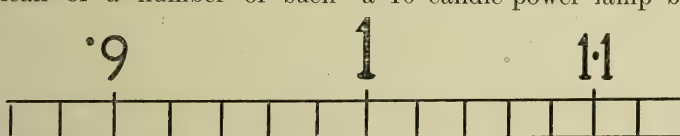


FIG. 69.

(*To be continued.*)

Annual Meeting of the Illuminating Engineering Society (United States).

DURING the month of January the annual meetings of several of the cheif sections of the Illuminating Engineering Society were held.

We note that the new officers of the New York section have now been elected—Mr. E. L. Elliott, Editor of *The Illuminating Engineer* (New York), being selected as Chairman, and Mr. A. J. Marshall, of the Bureau of Illuminating Engineering as Secretary.

ON March 18th a meeting of the New York Section is also to be held at which two papers are to be presented by Mr. Basset Jones, Jun., and Mr. A. J. Marshall on 'The Mathematical Theory of Finite Surface Light Sources' and 'Illuminating the Editorial Offices of *The New York World*' respectively.

With a recent valuable paper by Dr. E. P. Hyde we deal elsewhere in the present number.

Photometry at the National Physical Laboratory.

On Friday, March 19th, the National Physical Laboratory was open to inspection, and a large party availed themselves of the invitation of the General Board of the Laboratory to be present.

Of chief interest to our readers is probably the photometrical equipment of the laboratory; this has recently been the subject of an article by Mr. C. C. Paterson, the head of the department, in our columns (*Illuminating Engineer*, vol. i. 1908, October, p. 845).

Some important work has been carried out on the comparison of various specimens of the 10 candle-power pentane standard in use in this country and in the United States during the last year.

Experiments are also now being made at the laboratory on metallic filament standard lamps; a special lamp of this kind, having three tungsten filaments all in one plane, and running at 1·5 watts per candle, was on exhibition. One difficulty in connexion with with the use and testing of such standard lamps is the difference in colour between the light from the metallic and the carbon filament. This may lead to a difference of about 1 per cent, even in the readings of skilled observers. Mr. Paterson mentioned, however, that a series of lamps of graduated efficiency had been intercompared, "in cascade," with the object of achieving the comparison of two lamps of say 1·5 and 4 watts per candle by steps, each involving but little difference in colour. Under these conditions results were obtained by four observers differing by less than 0·3 per cent. This "cascade" method of comparison, therefore, is believed to lead to the more reliable results, from the physiological standpoint.

Another exhibit of interest was the system of carrying out life-tests in accordance with the engineering standards specification. The lamps are tested on racks, usually in a vertical position; arrangements, however, can be made to enable any rack to be inclined at an angle should this be desired. The pressure across all these lamps is regulated within ½ per cent by the special regulator devised at the laboratory.

The International Electro-Technical Commission and the Unit of Light.

At the recent Council Meeting of the International Electrotechnical Commission which was opened by Mr. A. J. Balfour in October last, the question of an International Unit of Light was brought forward by the French Electrotechnical Committee. The proposition of the French Delegates was, however, adjourned in order that the Electrotechnical Committees in the different countries might have an opportunity of further studying the subject. The Council also recommended that the Committee in each country should endeavour to arrange matters in such a way as to satisfy the needs of both the gas and electrical industries.

Considerable progress has been made here, and the British Committee has now appointed a Sub-Committee under the Chairmanship of Dr. R. T. Glazebrook, F.R.S., to go fully into the details of the question. Dr. Glazebrook will be assisted by Dr. S. P. Thompson, F.R.S. (British Delegate to the Commission), Prof. C. V. Boys, F.R.S., as official representative of the "Gas Referees," and Mr. J. W. Helps, M.Inst.C.E., officially nominated by the Institution of Gas Engineers.

With the cordial co-operation of the gas industry, thus obtained, it is hoped that the Sub-Committee may be in a position to report at no distant date, especially in view of the experiments lately carried out at the National Physical Laboratory, which point to the probability of an eminently satisfactory solution.

Notes on Incandescent Gas Lighting.

By Dr. C. Richard Böhm.

The Position of the Incandescent Gas Lighting Industry.

Incandescent gas lighting, from small beginnings, has now come into very general use indeed, and its applications and developments are still extending.

The inverted gas light, which is even cheaper than the ordinary upright burner, and possesses many of the qualities of the electric light, facilitates the introduction of gas lighting in many cases in which electric light was formerly exclusively adopted.

In order to introduce the incandescent mantle in countries and districts where gas was not available, petroleum and incandescent spirit burners have been invented. Again, we now see in every town of importance the results obtained by gas lighting under pressure, particularly in Berlin, where they utilize sources of light of 1,000 and 2,000 candle-power, which surpass even the flame arc-lamp in intensity. In addition, attention must be drawn to the insertion of artificial silk mantles.

Incandescent lighting will certainly invade one market after another. The incessantly growing consumption of mantles at present reckoned to be about 220 million a year, demands greater and greater manufacturing facilities. In all probability the production in the whole world is distributed as follows :—

Germany	100,000,000	mantles
America	55,000,000	,,
Great Britain (including Colonies)	35 000,000	,,
France	15,000,000	,,
Austria	3,000,000	,,
Italy	2,500,000	,,
Belgium	2,000,000	,,
Russia	1,500,000	,,

Germany produces more incandescent mantles than any other country.

The mantles of the different makers now available are, in many cases, greatly superior to the original Auer variety. This improvement in the quality of mantles had been preceded by a corresponding development in methods of manufacture. Even small manufacturers were able, ten years ago, to make a profit by the production of this article. Nearly all the work was then executed by hand, and the initial expenditure of establishing a factory to manufacture incandescent mantles was small ; but machinery is now required for the production of mantles in the necessary quantities. Several million marks are now employed in this industry, and only through its being conducted on such a large scale has it become possible to sell really good incandescent mantles at such low prices.

The German manufacture of incandescent mantles, as regards annual output, probably reached its highest point in 1906–7, but more recently it has diminished, owing to the fact that the United States, Italy, Austria, Russia, England, France, and other countries have established factories and followed the German lead.

The manufacturing of incandescent mantles, however, is still to a great extent in German hands, and the majority of important factories are established near Berlin.

Competition between manufacturers in Germany has made the prices of mantles so low that it now seems impossible to supply a really good article at a cheaper rate. But the difference between a first-class mantle and one of an inferior quality is very marked. A manufacturer who uses cheap material is able to sell at a low price, and profits thereby ; but at present the maker who uses only the best material and most skilled labour in order to supply a good article suffers, because the public does not understand the nature of this difference in quality. As long as the public will buy mantles merely for

their appearance, these conditions will still prevail, though they are neither in the interest of the incandescent gas lighting industry nor the consumer.

II.—The Ramie Mantle.

At the beginning of the ninetieth year of the previous century the European Ramie industry was still in the first stages of its development, and there were a number of difficulties relating to the winding of the fibre to be overcome. In this connexion the energy of Baumgartner, director of the first German company devoted to this industry, in Baden, should be mentioned. He developed the process of treating the raw material by such mechanical and chemical means that it could be drawn into the finest threads, and in 1897 finally adopted the idea of making mantles out of this material. Buhlmann also took up this idea, and, in small works belonging to his brother, constructed the first actual Ramie mantles.

Drehschmidt, the director of the Municipal Gas Works in Berlin, early recognized, by the aid of photometrical tests, the advantages which Ramie mantles possessed over those of the ordinary cotton variety. Unfortunately, as the latter present a smooth surface, while the Ramie threads are rough in texture, the application of Ramie to the incandescent mantle industry had to contend with great initial difficulties, which are, however, at the present day completely overcome.

At the present time the entire production of mantles in the world may be divided into 25 per cent cotton, and 75 per cent Ramie types, the cotton type being mainly manufactured in foreign countries. Ramie yarn to be used for making mantles must be prepared in a special way so as to be as free as possible from impurities. A few years ago they were exclusively treated with cocoanut oil in the drawing process, in order to facilitate the winding. More recently fatty substances have been used for this purpose but little, and winding is now carried out with the aid of paraffin.

The objection to the cotton mantle was that during its life it tended to draw itself out of the hot zone in the flame, and very quickly lost its original candle-power. Ramie mantles, on the other hand, maintained their form with much greater constancy, so that the duration of time during which their light was not appreciably affected was considerably increased. For instance, the best cotton mantles at that time lost 50 per cent of their initial candle-power of the first 100 burning hours, while the reduction in light from the Ramie mantle in the same time would scarcely be more than 10 per cent; indeed, in the case of certain individual makes the intensity was often increased. The Ramie mantle, on the average, maintains its light for 600 hours without any very marked diminution, provided, of course, special unfavourable circumstances such as dust, excessive moisture, &c., do not cause it to deteriorate. An approximately constant source of light is, of course, very desirable, in the case of all methods of illumination, and the properties of the Ramie mantle enabled it often to be preferred to the electrical carbon-filament glow-lamp which, as is well known, deteriorates during its life very quickly.

In addition to this constancy in illuminating power, the Ramie mantle possesses the advantage of being distinctly more efficient initially. Since its general introduction, incandescent gas lighting, even in the eyes of the non-technical observer, has materially improved. The reason for the increased emission of light from the Ramie mantle can be ascribed to the rough nature of its surface, which is comparable to the numberless small bristles characteristic of velvet; as the result a considerably increased radiating surface is obtained. In addition, the durability of the Ramie thread is considerably greater than that of cotton, because one can draw finer fibres out on a machine than is possible in the case of cotton materials.

This quality of Ramie thread has enabled makers to dispense with a treated fibre, and as a result the durability of the layer of oxide of a mantle is greater; there are fewer windings, kinks, or other interruptions, such as were inevitable in the case of the old stranded cotton fibres.

It may be mentioned that the general impression that a Ramie mantle cannot be prepared in a colodianized condition is erroneous. It arose through the circumstance that the first Ramie mantles, following the tradition of treated cotton fibres, consisted, like them, of triple stranded threads.

As will be understood from the above remarks the Ramie mantle now occupies almost exclusive attention in German markets. It has also several notable technical advantages as regards winding processes.

For instance, Ramie can be wound on the so-called "Kreuzspulen" (that is paper bobbins weighing only half a kilogram) successfully, while the cotton materials, which even to-day still utilize stranding, must be wound on special wooden rollers on the drawing machine.

(*To be continued.*)

Report on Conditions of Lighting in Workshops.

The Conseil d'Hygiène de la Seine have recently taken up the consideration of the important question of factory lighting; a report on this subject has been presented by MM. Chantemesse and Walckenaer, and is commented upon in a recent number of the *Revue des Éclairages.*

Artificial illumination, it is pointed out, is apt to have a fatiguing action upon the eye, largely because the position of the sources is frequently more or less incorrect, from the hygienic standpoint. In addition it differs from daylight in composition. It is difficult to secure conditions as good as those prevailing in a workshop illuminated by diffused daylight. In such a case the intensity near the window may amount to 40 or 50 lux.

As regards intensity 15 lux usually suffices; in some factories even 5 lux may suffice. As regards quality stress is laid upon the effect of the atmosphere in absorbing the violet and ultra-violet radiations to a large extent. The more refrangible rays promote visual acuity without contributing very essentially to the total brightness of the source.

Above all it is regarded as essential to keep bright sources out of the direct line of sight. It is also most important that the intensity of illumination should be adequate. Otherwise the strain of trying to work by feeble light leads to myopia and other troubles of the eyes.

Apart from these effects upon eyesight, however, workshops lighted by artificial means *alone* are particularly unsatisfactory on many grounds, for instance, on account of the resulting tendency towards deterioration of the atmosphere, and also because the microbe-destroying action of sunlight is lost. Still, it is not proposed absolutely to forbid such conditions, but only to make it clear that, when the means of illumination are entirely artificial, special care should be exercised.

The authors of the report also review the legislation of foreign countries on this subject. It is interesting to note that, apart from regulations affecting vitiation of the atmosphere, &c., a minimum working illumination of 10 candle-metres is specified in Holland.

In concluding the report it is explained that at present no definite regulations are to be prescribed, some general recommendations only being put forward. For instance, it is recommended that light walls, &c., should be employed in order to favour the diffusion of light from the sources installed. It is also recommended that tints of a yellowish character should be employed, in order to suppress the very refrangible rays. Arc-lights ought always to be screened, and inverted systems of lighting are spoken of favourably, and special stress is laid on the necessity of keeping all sources outside the field of view; to this report we hope to refer in greater detail later.

The Production and Utilization of Light.

Laws and Measurement of Radiation.

By Dr. C. V. Drysdale.

(*Continued from p.* 102.)

The law of Stefan, though of great practical value, only deals with the total radiation from a black body, and gives us no clue to its distribution over different parts of the visible and invisible spectrum, which is of such importance to us.

Wien's Law.—In 1893 W. Wien* published a remarkable theoretical investigation on the distribution of energy in the spectrum of a black body, on the lines of Boltzmann's theoretical proof of the Stefan law, combined with Doppler's principle of the change in the wave length, consequent on a movement in the line of propagation. His first results were to show that in the curve connecting the intensity of radiation of a black body with the wave length there was a maximum intensity corresponding to a certain wave length, which is termed the dominant wave length, and that the product of this dominant wave length and the absolute temperature of the body remained constant for all temperatures. This result which is frequently spoken of as Wien's "displacement law," is of great importance, as will be seen shortly. At the same time he also proved that the intensity of radiation at this dominant wave length was proportional to the fifth power of the absolute temperature.

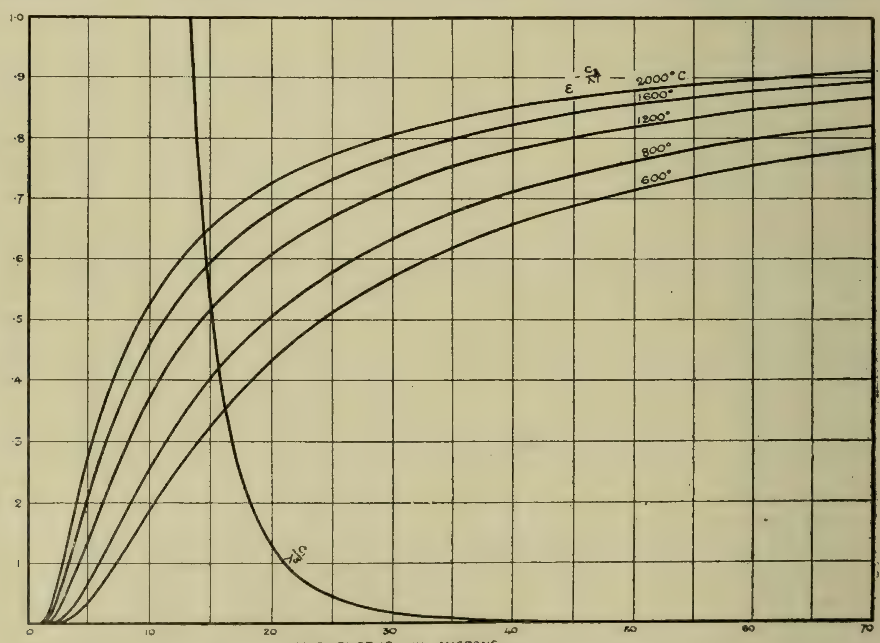


Fig. 1.—Variation of Factors of Wien's Formula.

* Berl. Ber., 1893, Sitzung vom, 9 Febr. See Drude's 'Theory of Optics,' p. 516 *et. seq.*

Up to this point Wien's investigations had been conducted by rigorous if ingenious application of recognized laws. In 1896, however, he published a second communication,* in which by the aid of certain assumptions as to the motions of the molecules and the

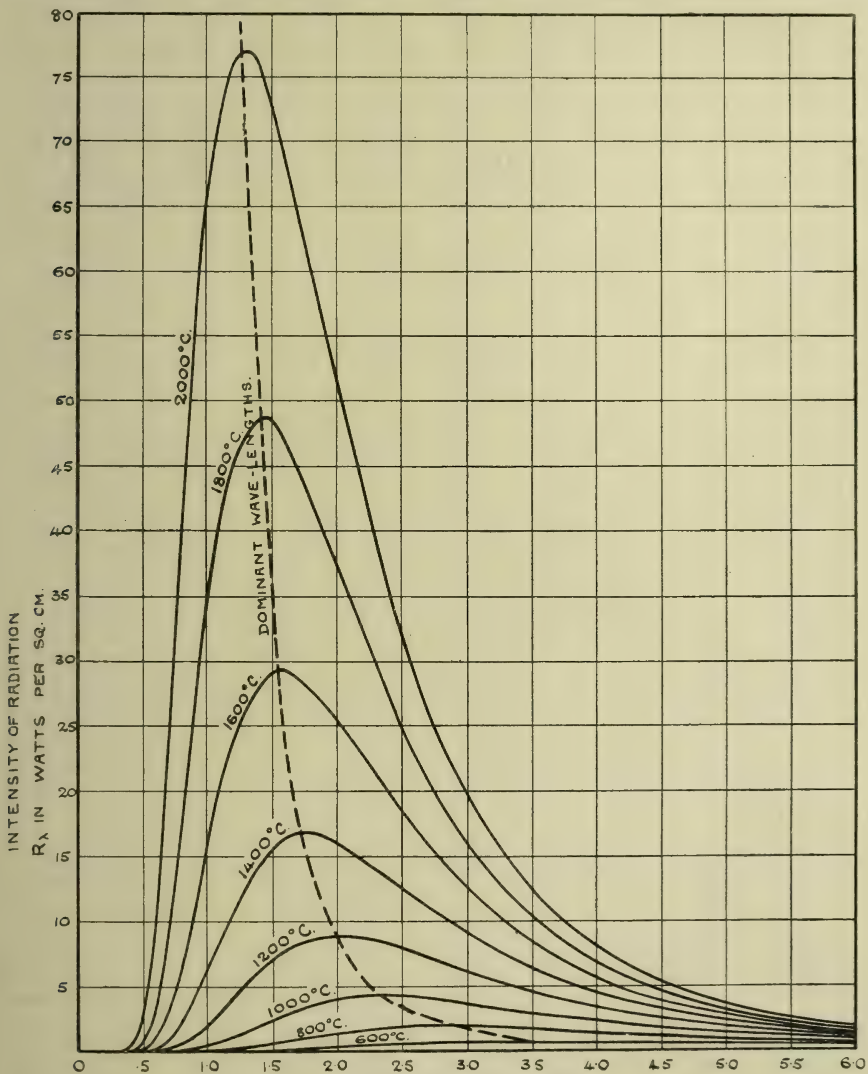


FIG. 2.—Curves of Energy Distribution for Spectrum according to Wien's Law.

waves emitted by them he was able to obtain a law or formula giving the complete relation between the intensity of radiation, the wave length, and the temperature of a black body.

This law can be written in the form :

$$R_\lambda = C_1 \lambda^{-5} e^{-\frac{c_2}{\lambda T}}$$

where R_λ is the intensity of radiation at wav length λ (the ordinate of the spectrum energy curve), T the absolute temperature, and C_1 and C_2 are constants. As this formula has the most important consequences, we will proceed to study it more closely.

In the first place let us consider the form of the curve representing the

* Wied. Ann., LVIII., p. 662, 1896.

relation of R_λ to λ for a given temperature, which is, of course, the curve which is obtained by a line thermopile or bolometer carried along the spectrum of a body maintained at a steady temperature. It will be seen that R_λ depends upon the product of two factors, one of which, viz., λ^{-5} decreases rapidly as λ increases, as in Fig. 1, and becomes zero when λ is very large; while the other $e^{-\frac{c_2}{\lambda T}}$ is zero when $\lambda=0$ and rises to unity when λ is very large, as is shewn by the family of curves for various values of T in the diagram. The product of these two factors is thus zero for $\lambda=0$ and $\lambda=\infty$, and between them it rises and falls as in the curves Fig. 2, which resemble that obtained by Tyndall by a thermopile in the spectrum. Since C_2 is constant it is evident that if the temperature T is doubled, the second factor will have the same value for half the wave length, or its curve will rise more steeply, with the result that R_λ will rise earlier and reach a greater height before falling away again. The curves in Fig. 2 have been calculated in this way, and show clearly how rapidly the maximum height increases, and the dominant wave length decreases as the temperature is increased.

Next we can find by simple differentiation the dominant wave length for each temperature. For since the dominant wave length is that for which $R\lambda$ is a maximum we have only to put the formula in logarithmic form

$$\log R_\lambda = \log C_1 - 5 \log \lambda - \frac{C_2}{\lambda T}$$

from which $\frac{1}{R_\lambda} \frac{dR_\lambda}{d_\lambda} = -\frac{5}{\lambda} + \frac{C_2}{\lambda^2 T} = 0$

for R_λ maximum, and $\lambda_{max}T = \frac{C_2}{5}$ where λ max implies the dominant wave length corresponding to the absolute temperature T. This is the displacement law of Wien above referred to.

The logarithmic equation above shows that if we measure the intensity of radiation for a given wave length, at different temperatures, there should be a straight line curve called the "isochromatic line" between $\log R_\lambda$ and $\frac{1}{T}$, from which C_2 can be determined. This was first done by Paschen and Wanner,* who measured the relative intensities of emission at given wave lengths by a spectrophotometer, and obtained a mean value of C_2 of 14,440, when T was in absolute degrees centigrade, and λ measured in microns (1 micron=1000th mm.). More recently Lummer and Prengsheim† have found 14,700 to be a more accurate value.

The value of this result will now be immediately apparent. From the equation $\lambda_{max}T = \frac{C_2}{5}$ we have $\lambda_{max}T = 2940$, using the Lummer and Pringsheim value for C_2. This enables us to find the dominant wave length of a black body whenever its temperature is known, or the temperature from its wave length. For example, if we take a carbon glow-lamp filament at a temperature of 1800°C.=2073° absolute, we have $\lambda_{max} = \frac{2940}{2073} = 1{\cdot}42\mu$ which is far outside the visible spectrum. In the case of the crater of the arc, which is probably at a temperature of 3500°C.=3773° absolute, the dominant wave length becomes $\cdot 78\mu$, or just at the extreme limit of the red end of the spectrum. On the other hand, it is obvious that the maximum efficiency of the light from a black body would probably be attained if its dominant wave length were that to which the eye is most sensitive, which has been found to be $\cdot 54\mu$. For this purpose T should be $\frac{2940}{\cdot 54} = 5450°$ absolute or about 5180° C., which is enormously greater than we can expect to attain, even if we could find any substance refractory enough to stand it. It is worthy of note that this result is not far from the temperature of the sun as found by Prof. Féry, which obviously means that the human eye has become adapted to the light which is provided by nature.

* Berlin. Akad Sitzungsber. II., p. 5–11, 1899.
† Verhand. d. Deutsch Phys. Gesell. 1, 12, 1899

(To be continued.)

The Effect of Light of Different Colours on Visual Acuity.

By J. S. Dow.

A considerable amount of research has been expended upon this subject by physiologists of the past. It is unfortunate that much of this work is only to be found in scientific transactions in Germany and elsewhere, with which the illuminating engineer is not in general acquainted, and that the literature is so very scattered.

It is, however, gratifying to observe that increasing efforts are now being made to study these questions from the practical standpoint of illumination. For instance, an account of some very interesting work on this subject has recently been published by MM. Laporte and Broca (*Bull. Soc. Int. des Electriciens* June, 1908). Still more recently a paper has appeared by Prof. S. W. Ashe in *The Electrical World* (Feb. 25th) describing some experiments, which led to somewhat different results.

Prof. J. A. Fleming, in his well-known paper on photometry before the Institution of Electrical Engineers in 1902, drew attention to the desirability of distinguishing between two distinct qualities of illuminants, namely the "power of creating brightness" and the "power of revealing detail." He also proposed the use of so-called "discrimination - photometers," based on acuteness of vision, in which two lights were compared by their relative ability to enable the eye to distinguish fine detail.

That some method of comparing this quality of revealing detail on the part of light of different colours is desirable may be admitted. But at the same time the author would suggest that such a test must be regarded as quite distinct from "photometry" as the term is usually understood, and has only a restricted application. For the use of light in order to enable the eye to perceive very fine detail, to read print for example, though an important function of illumination, is only one among many purposes for which light is intended. And, apart from any question of the relative accuracy of the two systems, it seems probable, at the present moment, that our method of comparing the powers of "creating brightness" on the part of illuminants is the best test of their general value.

In attempting to study the question under consideration it is desirable to form a fairly exact idea as to what is meant by "visual acuity." The generally accepted sense in which this term is used seems to be "the ability of the eye to perceive fine detail," such as small print, &c. Occasionally, however, people seem to have used the expression to denote the power of appreciating fine distinctions of light and shade, which is a somewhat different matter, though, of course, also important and closely connected with visual acuity.

It may also be pointed out that there is some vagueness about statements to the effect that certain varieties of light are "good for reading." Is it meant, for instance, that the type appears exceptionally sharp and distinct to the eye when illuminated by this light? Or that we can read a book so illuminated for an unusually long period without fatigue? It seems quite possible that these two conditions may not be identical.

It is, indeed, very difficult for an engineer or physicist who does not secure the co-operation of some one closely in touch with the latest developments in physiological optics, to avoid his results being vitiated by some physiological effect which is apt to obscure the real point at issue. This point may be stated as follows :—

Suppose a white surface, on which is inscribed some fine black detail, such as small letters, is illuminated in turn by light from different portions of the spectrum, the light being adjusted in

such a manner that the surface appears equally bright to the eye in each case. Under these conditions, will the detail be clearer and more easily perceived by the eye by light of one particular colour; if so, which kind of light is best for the purpose?

In order to study this question it is essential to treat both kinds of light fairly by securing that the surface appears to have the same brightness in each case. It is, of course, no easy matter to compare accurately the brightness of two adjacent surfaces, illuminated by lights differing in colour, but the experiences of many observers suggest that there is no insuperable difficulty in making an approximate judgment. On the other hand, it would seem desirable to make sure *by actual observation* that the brightness really does seem to be the same in each case, and not to calculate from some assumed law that it is so. Therefore in making experiments on this matter the writer has employed a wedge, the two sides of which could be illuminated by two heterochromatic sources, as shown in the diagram (Fig. 1). Transparent lantern-slides, on which detail of various kinds had been photographed, were then placed in front of the wedge so that this detail could be viewed simultaneously by the aid of the illumination of both colours; some of these acuteness of vision charts are to be seen in Figs. 2a, 2b, 2c, 2d.

MM. Laporte and Broca, in their researches, used a similar arrangement. It has at least the merit of enabling us to feel sure that we are really comparing the detail-revealing powers of the two qualities of light studied, under approximately equal conditions as regards illumination. It may be added that in the arrangement used by the author provision was made for the distance of the eye from the detail being maintained constant and measured.

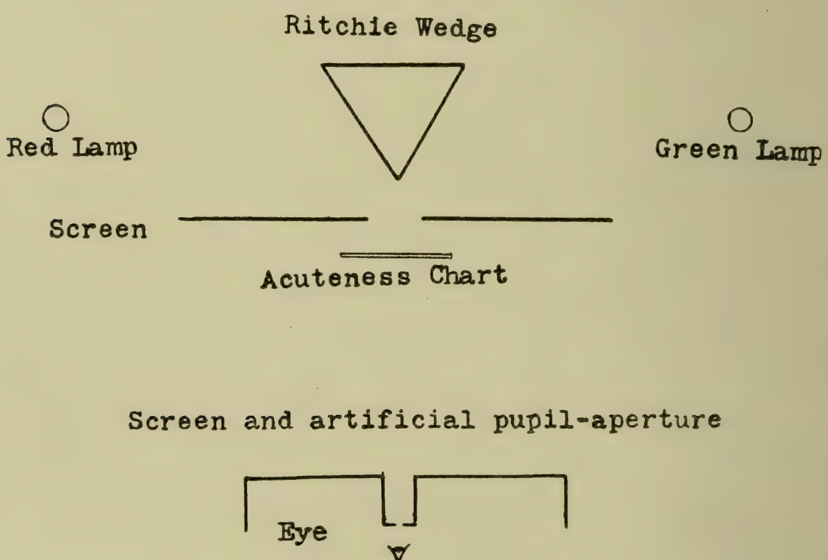


FIG. 1.—General Arrangement of Apparatus.

Prof. Ashe appears to have calculated the illumination by which his tests were conducted by the inverse square law, and to have used a flicker-photometer. The writer, however, would venture to suggest that this method is not so satisfactory. In the first place it is legitimate to question whether, in a research of this kind, where lights of such different colours are used, readings of a flicker instrument constitute an entirely satisfactory method of judging "equality of brightness," on the maintenance of which the whole value of the experiment depends; in addition, according to his experience,

theoretical calculations of illumination are apt to be very misleading in heterochromatic comparisons owing to the disturbing influence of the "yellow-spot" and Purkinje effects.

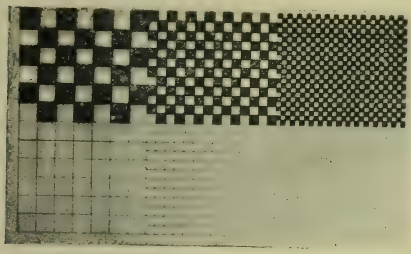


FIG. 2a.

Many observers have attempted to compare the "visual acuity" in different portions of the spectrum by placing a small object in the eye-piece of a telescope in the spectrometer, and gradually dimming the illumination until it became indistinguishable. Naturally such experiments have not infrequently suggested that greenish-blue light was the best, but probably merely because, at the very low order of illumination necessary to cause the object to appear indistinguishable, this is the region of the spectrum where the *luminosity* is greatest; therefore, they can hardly be taken as an illustration of the relative detail-revealing powers of different regions, *for the same intensity of illumination*, and at ordinary high illuminations. Instruments which depend upon the dimming of the existing illumination to very low values seem to the writer to be open to objection, on the ground that they utilize the illuminants compared under physiological conditions, which are apparently quite different from those prevailing at ordinary working illuminations. It may be suggested that, as a matter of principle, such measurements should be undertaken at the actual order of illumination which the illuminants will be required to supply.

Another possible source of uncertainty in making tests of visual acuity by lights of different colours is brought into play by adopting the plan of setting up some type of a given size, and then walking backward until it just becomes indistinguishable. Here, again, the visual angles thus calculated may fail to afford a fair comparison of the acuteness of vision by different qualities of light, because, in walking away from the object, we bring into play a different region of the retina, and so alter, not only the visual angle, but also the *apparent brightness of the illumination.* The central region of the retina has been found by many observers to be less sensitive to the blue and green end of the spectrum than the surrounding region, Hence, although we may secure that the illumination is the same in the case of the two colours compared at close quarters, this may be no longer the case at a distance. For this reason also the writer prefers an arrangement in which the eye is maintained at the same constant distance from the two illuminated surfaces during the experiment, and the visual angle is altered by some method other than withdrawing the eye.

In order to be able to vary the visual angle subtended by the detail studied without altering the distance of the eye, the author has sometimes made use of graduated detail of the variety such as the tapering striped pattern shown in Fig. 2b. In this case a measurement of visual acuity was secured by noting the exact point at which the eye was unable to detect the transition from the black stripe to the adjacent white one.

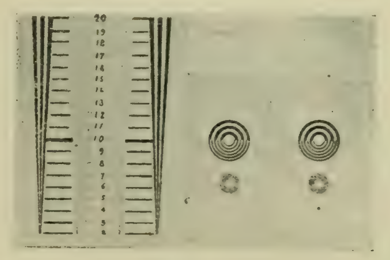


FIG. 2b.

In using the apparatus described, however, the author first attempted to use a discrimination-photometer on

the lines laid down by Dr. Fleming (*loc. cit.*), using the pattern of fine dots (Fig. 2c) at such a distance from the eye that the dots just fell within the minimum visual angle of distinct vision (about 1 minute). In a photometer of this type one merely seeks to balance the illumination so that the sets of dots superimposed over both fields in the photometer became equally distinct. An artificial pupil-aperture of 2mm. diameter was used, this being considered sufficient, at the order of illumination employed, to be well within the minimum value assumed by the author's eye.

The experiments were carried out with incandescent lamps screened with gelatines and solutions of various colours. Naturally the tints so obtained do not quite correspond with pure spectral colours. There are, however, organic dyes which, in solution, or spread upon gelatine surfaces such as "fixed" photographic plates, enable a very pure red or green light to be obtained, though naturally at the expense of a considerable loss in light. The purity of these colours was studied by means of spectrometric examination; though not quite equivalent to pure spectrum tints they should probably answer the purpose of exhibiting qualitatively the main phenomena examined.

The result of his efforts to utilize visual acuity as a basis of photometric balance the author must confess to have been discouraging. It appeared that there were two distinct criteria affecting one's judgment of "balance." It was found that there was a distinct difference in sharpness in the case of different colours. But this sharpness seemed to be a purely optical effect connected with the accommodation of the eye and apparently unaffected by the illumination within wide limits. It was, in fact, possible to secure greater *sharpness* of the pattern with light of a certain colour, in spite of an obviously lower order of illumination.

On the other hand, another possible criterion of balance was the *contrast* between the pattern and its background, *i.e.*, the extent to which the pattern "stood out"; if this be the condition by which judgments are based the instrument would be used as what might be termed a "relief-photometer." In this case it was found that, when linear detail was used, the method led to results practically equivalent to those obtained by the "equality of brightness" method When patterns consisting of alternate light and dark patches were used, however, the matter seems to become more complicated, possibly because the eye no longer judges the brightness of the mass as a whole, but selects the individual bright patches, For instance, to the writer it appeared that, when the chess-board pattern (Fig. 2a) was superimposed over two patches of, say, red and green of equal apparent brightness, the small red squares in-

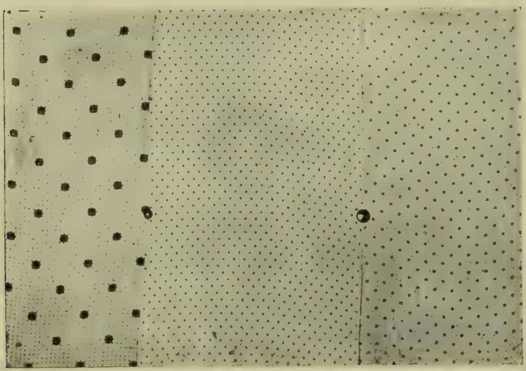


FIG. 2c.

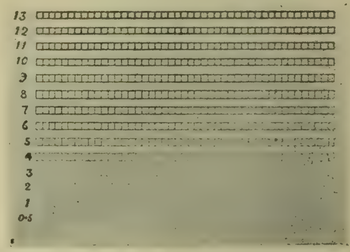


FIG 2d.—Graduated Detail.

variably appeared brighter than the small green ones, though somewhat less sharp. This is what would be naturally expected when it is recalled that the effect of using smaller illuminated surfaces is usually to favour the red end of the spectrum owing to the lack of sensibility of the central portion of the retina to the region from green onwards.

In any case it would seem that the effect of superimposing detail of this kind over the illuminated surface is to introduce complications, and the writer's experience is that it tends to cause bewilderment rather than to assist judgment in attempting to balance the photometer; he personally would prefer to judge by "equality of brightness" pure and simple as far as convenience is concerned.

A number of experiments were also carried out with graduated patterns of the type shown in Figs. 2b and 2d with the object of comparing the visual acuity obtainable with light of different colours. As a result it seemed that even for more or less pure green or red light there was not a very marked difference in visual acuity to be observed in the case of near vision. It appeared, however, that there was a distinctly better result obtainable by using the green end of the spectrum, as is illustrated by Fig. 3.*

The ordinates in Fig. 3 correspond with the scale of acuteness in Fig. 2b.

It is interesting to observe that the really sharp bend in the curve occurs about 0·5 candle-metres. When allowance is made for the use of an artificial pupil-orifice (which, of course, diminishes the apparent illumination), this result agrees very well, under the circumstances, with the value of 0·2 candle-metres, which other experiments of the writer have suggested to be about the order of illumination at which "cone-vision" is believed to be replaced by "rod-vision" when the field of view subtends a relatively small angle at the eye.

These experiments have been repeated under many different sets of conditions, and there seems no doubt that, in the case of the author, the red end of the spectrum is not so good as the blue, and as far as the sharpness of fine detail is concerned, *in the case of near vision.* This result is therefore qualitatively in agreement with that reported by Prof. Ashe (*loc. cit.*). It is also in agreement with that of MM. Laporte and Broca to the extent that such difference in visual acuity, as seems to exist, even for red and green light, is not very marked, and it seems reasonable to suppose that for most ordinary illuminants the difference is, as these authorities find, still less appreciable.

On the other hand, it is interesting to recall that other observers seem to have come to an opposite conclusion. Thus L. Weber (*E.T.Z.*, 1884, p. 166), attempted to assist the judgment of the relative brightness of two different colours by super-imposing over the illuminated surfaces a series of concentric circles of various thicknesses somewhat similar to those shown in Fig. 2b. He seems to have found that, if such a pattern were superimposed over two surfaces of apparently the same brightness, the circles on the *red* ground appeared more distinct than those on the *green* ground. He therefore concluded that the most refrangible rays from green onward contributed but little to the detail-revealing power of illuminants, though adding considerably to their power of creating brightness, and he also cited the well-known previous work of Macé de Lépinay in support of this view. Yet it is curious to observe that the authors of the recently issued report to the Conseil d'Hygiène de la Seine (*Rev. des Eclairages*, March 15th) assert the exact contrary.

* The question may be raised as to the validity of the figures for intensity of illumination, based as they are on the comparison of heterochromatic sources. It should be mentioned that by an illumination of "1 lux" is meant that the coloured surface studied appears to the eye as bright as a similar surface illuminated by white light with this intensity. The actual determination of the brightness of the coloured sources, which must present difficulties, is uncalled for. The intensity of the brightness of the surface illuminated by the coloured light was obtained by actual comparison with white light; the figures given are, however, naturally approximate.

A possible explanation of this discrepancy that occurs to the author is that, in utilizing the series of concentric circles, Weber introduced the retinal effect previously referred to as characteristic of the "chess-board" variety of detail. The writer himself, when utilizing the concentric circles in Fig. 2b certainly received the impression that *the black circles on* the red ground "stood out" more: in other words the red circles appeared *brighter* than the corresponding green ones. Nevertheless the green circles seemed to him the *sharper*.

Hitherto the remarks on visual acuity have referred mainly to close vision, and are therefore applicable to the conditions characteristic of reading and writing. In spite of the use of an artificial pupil-aperture it was found that care was needed to avoid the consequence of obtaining occasional abnormally acute readings owing to the eye making a special effort, apparently due to an unusually severe effort of accommodation. Short-sighted people presumably fail to read a book at a certain distance, because they are unable to focus the letters sharply, and details therefore appear blurred. In the same way it may be suggested that the normal eye does not, as a rule, attain *quite* the sharpest image possible; when called upon for a sudden effort, however, it may accommodate more than usual, and thus secure rather sharper images and slightly improved visual acuity. On this supposition the sharpness of the image is largely a matter of accommodation.

There would seem to be a reason why a sharper image should be obtained by green light, in the case of near vision. This rests upon the want of achromatism of the eye, a matter to which the writer has drawn attention elsewhere (*Illuminating Engineer*, New York, March, 1907). The result of this want of achromatism is shown in Fig. 4, which is taken from Tscherning's physiological optics.

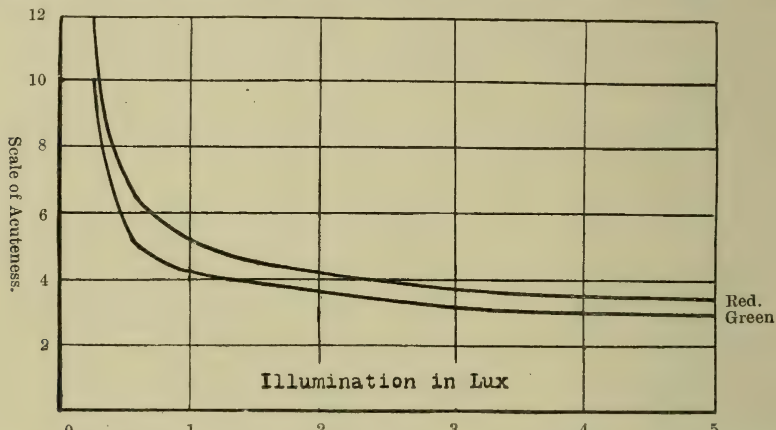


FIG. 3.—Visual Acuity for Red and Green Light, Near Vision (Distance of Eye, 30 centimetres).

Let A be a luminous point which sends the cone of light A, B, C, into the eye. After refraction the violet rays are separated out and brought into focus at V, while the red rays are brought to a focus on the other side of the normal position of the retina. Since sunlight and most artificial illuminants contain chiefly yellow light the retina of the eye commonly adjusts itself to yellow light and assumes a position midway between these points.

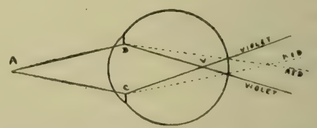


FIG. 4.—Want of Achromatism of Eye.

When the eye is brought very close to a small luminous white object it becomes easier to accommodate for

violet than for red light, and we usually see the white object surrounded by a red fringe. But when the eye is removed to a distance of, say, 10 feet from the object the state of things is reversed. It is difficult, however, to see the violet-blue fringe produced in this way because of its low luminosity.

This effect is very clearly shown by several well-known experiments, some of which have been described by Shelford Bidwell ('Curiosities of Light and Vision'). Note, for instance, what happens when we observe a naked glow-lamp filament through cobalt glass—a glass which allows both blue and red rays to pass, but obstructs the intermediate portion of the spectrum. When the eye is only a few details. The author has also made a series of tests at the Birkbeck Institute with the large chart from which the striped diagram used to obtain the results shown in Fig. 3 was reproduced. This chart was arranged as shown in Fig. 5.

In Fig. 6 are shown the points at which the stripes became indistinguishable, as the distance from the eye was increased. It may be mentioned that the illumination due to the red and green lights was equalized anew before each reading. There seems to be a very distinct difference in the acuity between the two colours, almost as great as exists between the author's left eye, which is normal, and his right, which is distinctly short-sighted.

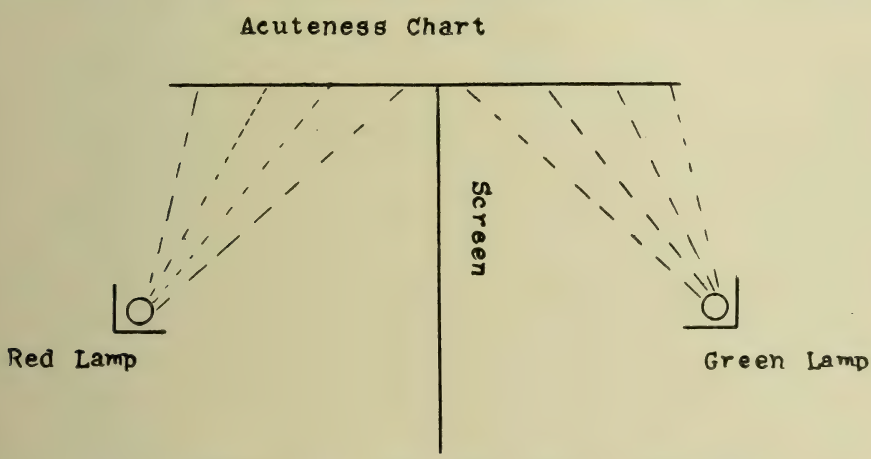


FIG. 5.—Arrangement for Testing Visual Acuity for Distant Vision.

inches away we see a purplish filament with a distinct red fringe.

But when the filament is observed from a distance of a few feet we see a reddish filament surrounded by a distinct ribbon of blue light. As the distance of the observer is still further increased this blue ribbon ultimately becomes a shapeless blue haze, but the filament appears red. In the case of the author this happens at a distance of about 20 to 30 feet, but these results, are, of course, modified by any optical peculiarities that may be present in the observer's eye.

Now this property of the eye may be expected to have an important influence on its power of observing

It would seem that most people find themselves distinctly short-sighted for light from the blue and violet end of the spectrum, and in the case of distant vision. For instance, in a demonstration at a meeting of the Physical Society of London in 1908, a black-and-white pattern was illuminated by two patches of red and blue-violet light, produced by placing some specially designed gelatines in the beam of a lantern. The brightness of the red was intentionally reduced to but a fraction of that of the blue-violet patch. Nevertheless those at the back of the room agreed that the detail illuminated by the former was incontestibly the sharper and the easier to distinguish.

Very striking results may be obtained by the use of the mercury vapour lamp, which is particularly serviceable for obtaining pure violet light.

It should, however, be stated that the writer has met with a few people who confessed themselves unable to see any difference at all, and it may therefore be urged that any really authoritative study of this subject must contain investigations on a large number of eyes in order that conclusive results may be established; it is hoped, therefore, that the experiments described in this article may lead others to examine the matter more fully.

To sum up, therefore, it would seem that the blue-green end of the spectrum is somewhat advantageous for very close work, but not so good as red light for the illumination of objects or patterns to be distinguished at a distance.

Possibly, indeed, it might be found advantageous to illuminate distant object—clocks and so forth—with red light, which would also serve the purpose of distinguishing them from surrounding objects, and tend to attract attention.

It is obvious, however, that, if an eye is permanently short-sighted for light of a particular kind, and is unable to bring it to a focus under certain conditions, no amount of such light, however great, could enable it to see detail so illuminated satisfactorily.

It may be suggested that the considerations urged in what has gone before would lead us to avoid utilizing tests of visual acuity for the purpose served by those of a photometrical nature. When we consider that it is apparently possible for detail upon a surface illuminated weakly by light of a certain kind, to appear more distinct than if illuminated with far greater intensity by light of some other variety, we must admit that visual acuity is an unsatisfactory method of testing the illuminating power of sources.

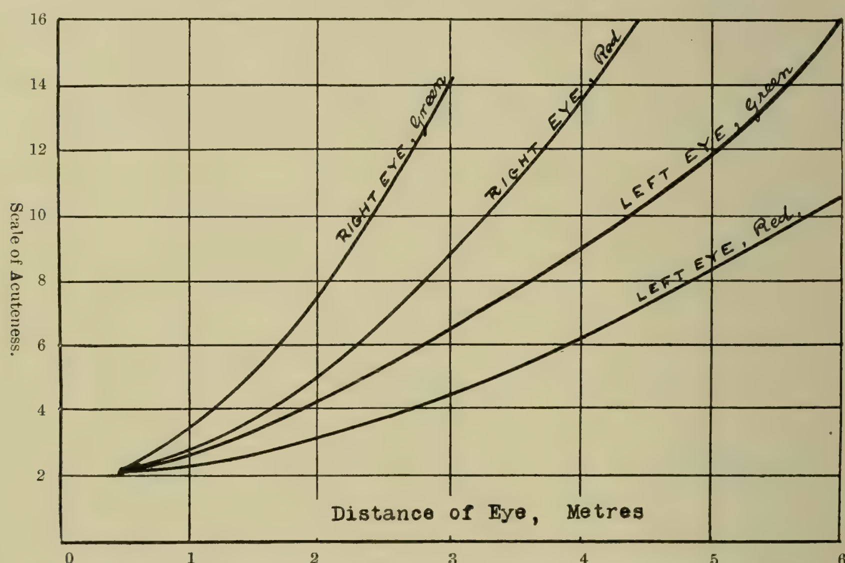


Fig. 6.—Visual Acuity for Red and Green Light, Distant Vision.

The Selective Emission of Incandescent Lamps as Determined by New Photometric Methods.

By E. P. Hyde, F. E. Cady, and G. W. Middlekauff.

(A paper presented at the February meeting of the New York section of the Illuminating Engineering Society.)

The recent development of high-efficiency metallic-filament lamps has aroused new interest in the measurement of the high temperatures of glowing metals, and has raised the question as to whether the high efficiencies are due primarily to the high temperatures at which the filaments operate, or to a selective radiation, where by selective radiation is meant that the distribution of the energy in the spectrum of the radiating body at a given temperature is different from that of a black body at the same temperature.

Although much is known regarding the laws of black body radiation, we know very little as yet about temperature-energy curves of material substances, principally on account of the difficulty of determining with any degree of accuracy the temperature of the surface which is emitting the radiation. Recently, in connexion with the photometric study of the new metallic filament lamps, there were developed two new photometric methods which may be used to give valuable information in regard to the radiation from substances which can be formed into filaments and mounted in exhausted bulbs.

The theory of these two new photometric methods was presented at some length by one of the present authors before the American Physical Society at its October meeting. Inasmuch, however, as no provision has yet been made for the immediate publication of this theory it may be well to give a brief outline of it before passing on to the results obtained by its application to a study of the radiating properties of the various carbon and metallic filament lamps in common use at the present time.

There are two distinct ways in which the radiation from two different solid bodies having continuous spectra may differ when the bodies are at the same true temperature :

1. The distribution of the energy throughout the spectrum may be the same in the two cases, but the total amount of energy radiated may be different; that is, the form of the energy curves may be the same, but the heights of the ordinates may be different—the ratio of the ordinate of one curve to that of the other being a constant factor of proportionality for all wave-lengths.

2. Not only may the total energy radiated be different, but the distribution of the energy in the spectrum may not be the same for the two substances.

If there be taken as the standard radiator the theoretical black body, that is, one which absorbs all incident radiant energy, the radiating properties of other bodies can be described in terms of black body radiation which is a function of the temperature only. No body for which the radiation depends on temperature rather than on luminescence, can have a greater emissivity than a black body at the same temperature.

A body which has the same form of radiation curve as the black body at the same true temperature, but which radiates less energy in every portion of the spectrum, is ordinarily termed a "grey body." It is evident from this definition that corresponding to a black body at any temperature there may be theoretically an infinite number of grey bodies, differing only in the total amounts of radiation, that is, having different emissivities.

A body which not only radiates less energy than a black body, but for which the form of energy curve is different from that of the black body at the same true temperature, will be defined as a "selectively radiating body."

A body showing this property of selective radiation, or "selectivity," as it may be termed, will radiate relatively more energy in one part of the spectrum than in another, as compared with the radiation from a black body at the same temperature.

From these definitions it is evident that a grey body is no more efficient as a luminous radiator than is a black body at the same temperature, because the ratio of the energy emitted in the visible spectrum to the total energy radiated is the same for the grey and the black bodies when both are at the same true temperature. However, if a body radiates selectively in such a way that relatively more energy is emitted in the shorter wave-lengths than in the longer wave-lengths, such a body would be a more efficient luminous radiator than a black or grey body at the same temperature.

The two photometric methods which have been developed in studying the photometric properties of the new filament lamps give positive qualitative criteria of selectivity. If one assumption is made which, although a probable one, has not been demonstrated to be true, one of the methods may be used to approximate quantitatively the amount of selectivity, and also to give an upper limit to the true temperature of the radiating body, just as the present methods of optical pyrometry give a lower limit to the true temperature.

To the knowledge of the writers two other methods have already been employed to give indication of selectivity. One of these methods consists in determining by means of a bolometer or radiometer the ratio of the energy emitted at any wave-length to that emitted at the wave-length of maximum energy, and computing from this ratio the constant which appears as an exponent in the equation $J_{max} T^{-a}$=constant. The value of a gives indication of the departure from black body radiation, but since the interpretation of differences in a is indirect, and the method has not been developed to any great extent, it will be passed over without any discussion whatever.

The other method, which was first outlined by Holborn in his original description of the Holborn pyrometer, and which was subsequently applied by Waidner and Burgess in their recent work, 'Preliminary Measurements on Temperature and Selective Radiation of Incandescent Lamps,' demands some attention. This method consists essentially in determining, by means of an optical pyrometer, the black body temperature using approximately monochromatic radiation in the red, green, and blue regions of the spectrum. If the black body temperature determined by means of the green radiation is higher than the black body temperature found by means of the red light, and the "blue black body temperature" is in turn higher than the "green black body temperature," it has been argued that the body emits relatively more green than red light, and relatively more blue than green, and therefore radiates selectively in favour of the light of shorter wave-lengths. Moreover, this property of selection, it is argued, will in all probability extend beyond the visible spectrum, so that the energy emitted in the visible spectrum will be relatively larger than that emitted in the infrared spectrum, as compared with the radiation from a black body at the same temperature.

This method, which is indicative, and therefore valuable in the absence of any more exact and simple method is, however, of limited application, and even within its limited field is subject to criticism. Thus, it does not necessarily follow that a difference between the red and blue black body temperatures of a radiating body indicates selectivity in the sense employed in this paper. In the case of a radiating grey body the blue black body temperature would be higher than the red black body temperature on account of the difference in emissivity between the grey and black body, and yet there would be no selectivity. The amount of difference between the red and blue black body temperatures will depend on the emissivity of the grey body; as the emissivity becomes smaller the amount of difference becomes greater. Without some knowledge, therefore, of the emissivity of the black body, it is

impossible to know whether the difference between the red and blue black body temperatures is to be ascribed to selectivity, or to a low emissivity.

The starting point in both of the new photometric methods which have been developed recently for studying selectivity consists in bringing the various radiating filaments to be studied to such temperatures that the relative distribution of energy in the visible spectrum of each filament is the same. That this can be done for all substances that are at present used in filaments of incandescent lamps has been shown by direct spectro-photometric determinations. For the time being we shall assume no knowledge whatever of the true temperatures of the filaments which may or may not be the same.

If any two bodies are brought to such temperatures that the distribution of energy in the visible spectrum of the two bodies is the same, and if, under these conditions, the distribution of energy throughout the entire spectrum is the same for the two, it is evident that the ratio of the energy emitted in the visible spectrum to the total energy radiated must be the same for the two bodies.

Applied to incandescent lamps, if the voltage of one lamp is kept constant and the voltage of the other is so altered that the distribution of energy in the visible spectrum of the two is the same, and if, under these conditions, the ratio of the energy emitted in the visible spectrum, as indicated by the candle-power, to the total energy radiated by the lamp, as shown by the electrical power supplied to the lamp, is found to be the same for the two lamps, evidently it is quite probable that the energy curves of the two filaments throughout the entire spectrum are relatively the same, and that, therefore, one lamp is not radiating selectively with respect to the other. Therefore, by bringing two lamps to the same distribution of energy in the visible spectrum and determining, under this condition, the lumens per watt for each lamp, there is obtained a positive qualitative criterion as to whether or not one lamp is radiating selectively with respect to the other.

Thus, if, under this condition of same relative distribution of energy in the visible spectrum, the lumens per watt of a filament of unknown radiating properties are compared with the lumens per watt of a filament which has characteristics of a black body, and if the lumens per watt of the two lamps are found to be the same, it may be concluded with reasonable certainty that the filament of unknown radiating properties has the characteristic of a black or grey body, although it is not possible to tell which.

Conversely, if the lumens per watt of the two filaments are different, it must follow that the filament of unknown properties does not have the characteristics of a grey or black body ; it must, therefore, be selective. So far there are no means of determining how selective the filament is, because the moment a difference in the energy curves is encountered, one can no longer argue that when the curves agree in the visible spectrum the two bodies are at the same temperature, and unless there is definite knowledge in regard to the relative temperatures of the two bodies it is not possible to draw quantitative conclusions as to the amount of selectivity of the selectively radiating filament.

The above method, therefore, gives a positive qualitative criterion for studying the relative selectivity of materials that can be mounted in the form of filaments in exhausted bulbs. It in only when one can assume that there is no convection or conduction of energy from the glowing filament that it is permissible to consider the total energy radiated as equal to the energy supplied to the lamp. Hence, the filaments must be mounted in exhausted bulbs.

(*To be continued.*)

Modern Methods of Illumination.

By Leon Gaster.

(Editor of *The Illuminating Engineer.*)

(The following is the Syllabus of four Cantor Lectures delivered before the Royal Society of Arts, Adelphi, W.C., on Monday Evenings, February 15th, 22nd, March 1st, 8th, at 8 o'clock, the second and third of which we abstract in this number, by kind permission of the Society.)

Lecture I. — *February* 15. — Electric Lighting.— Introduction — Incandescent Electric Lamps (Historical Summary)—Recent Developments of Nernst—Graphitized, Tantalum, Osmium, Tungsten, Helion, Mercury Carbon, and other Lamps—The Use of Transformers—Effect on the Lighting Industry (Central Stations, Manufacturers, and Consumers)—National Lamp Association and Standard Specification—Lines of Future Development. *Arc-Lamps.*—The Carbon Arc—Open and Enclosed Arc-Lamps—Miniature Arc-Lamps—Flame-Arc Lamps—Open and Enclosed with Inclined and Perpendicular Carbons—Arc-Lamps for Photographic and Medical Purposes—Applications and lines of Future Progress. *Use of Luminescent Vapour and Gases.*—Early Mercury Lamps—Cooper-Hewitt, Bastian, Vogel, Quartz-Tube, Küch, and Uviol Lamps—The Moore System of Luminescent Gases and its Applications.

Lecture II.—*February* 22.—Gas-Lighting.—Summary of Early Development of Gas-Lighting—Flat-Flame, Regenerative, and Enriched Gas-Burners—The Coming of the Incandescent Gas Mantle—Its Theory and Action—Soft Mantles and other New Developments—The Hella Bushlight. *High-Pressure Gas-Lighting.*—Selas, Millenium, Sale-Onslow, Pharos, Grätzin, Colonia, Keith-Blackman, Suggs, and other Lamps—Relative Merits of Compressed Air, Compressed Gas, and Mixture of Air and Gas—Self-Intensifying Lamps, Scott-Snell, Lucas-Thermopile, Welsbach, Chipperfield Lamps, &c. Automatic Lighting and Extinguishing at a Distance—Electrical and Pneumatic Devices—Self - Lighting Mantles—Liquid Gas—Blau, Wolf, and other Systems—Modern Problems in Gas-Lighting—Recent Developments in Street Lighting in London and Berlin — Candle-Power Standards *versus* Calorific Power of Gas—Lines of Further Researches: Livesey Professorship at Leeds.

Lecture III.—*March* 1.—Lighting by Candles, Oil, Acetylene, Petrol, Air-Gas, Alcohol, and other Illuminants.—The Candle and other Early Systems—The Petroleum Lamp: its Merits and Drawbacks; Decision of Third International Petroleum Congress *re* Safety of Lamps—Recommendations of using Efficiently the Ordinary Household Lamp—The Petrolite Lamp—High-Pressure Systems of Kitson, &c.—Modern Petrol Air-Gas Systems and their Merits—Examples of several Types and Generators—The Aerogen, Cox Air-Plant, De Laitte, National Air-Gas, &c.—Lighting by Alcohol and other Liquid Fuels—Acetylene: its Early Development and Difficulties Overcome—Modern Types of Burners—Applications to Incandescent Mantles—Liquid Acetylene—Transport Facilities—Lighting of Railway Carriages—Illumination of Buoys, &c.—Summary of Position of Modern Illuminants—Comparisons of Quality for Lighting and Radiant Efficiency—Researches for further Improvements.

Lecture IV. — *March* 8. — General Problems in Illumination and Illumination Measurements. — Daylight Illumination and its Variation during the Day and Season of the Year—Intrinsic Brilliancy of the Different Artificial Illuminants—Effect on the Eye—Methods of shading, Use of Frosted Opal and Holophane Globes and Reflectors—Spectra of various Illuminants—Possible Physiological Effects of Light of Different Colours—New Researches of Effect of Ultra-Violet Light on Sight—The Use of Euphos glass—Modern Methods of Measuring Light and Illumination: Exhibition of some of the Latest Apparatus—International Action regarding Standards and Units of Light—Lighting of Schools, Libraries, Factories, Hospitals, &c.—Illumination and Hygiene—The Work of the Illuminating Engineering Society—The Need of the Illuminating Engineer Expert: Description of his Functions—Concluding Remarks and Recommendations.

Each lecture will be fully illustrated by working specimens of the lamps and apparatus described.

Modern Methods of Illumination.

By Leon Gaster.

II.—Recent Progress in Gas Lighting.

(Cantor Lecture delivered before the Royal Society of Arts on February 22nd, 1909; the following abstract is made by kind permission of the Society.)

On Monday, February 22nd, at 8 p.m., Mr. Leon Gaster delivered the second of the series of Cantor Lectures on 'Modern Methods of Illumination' before the Royal Society of Arts, which will be published in full in the *Journal* of the Society, during the summer recess.

Mr. Gaster prefaced his lecture by a short reference to one or two matters unavoidably omitted in the previous one, and exhibited a few slides representing the thickness of different types of electric filaments, and the relative costs of different electric illuminants; he emphasized the conclusion that each case had to be discussed on its merits, and no very general decisive figures could be put forward.

Turning now to the subject proper of the lecture, Mr. Gaster dealt briefly with some of the points in the history of gas lighting, explaining how great were the difficulties encountered by pioneers in this country, and pointing out how the electrical profession, who had sufficient difficulties of their own to encounter, ought to be grateful for their efforts in overcoming early prejudices.

He next proceeded to describe the earliest types of burners. The earliest method of using gas was, of course, by the use of the so-called "bat's wing," or flat flame burners, which we should now consider extremely insufficient; they yielded only about 3 candle-power per cubic foot of gas even under the most favourable conditions. Of course, it must be remembered that gas, unlike electricity, might vary in quality in each district. For instance, the Act of 1860 prescribed that the town gas burned under certain specified conditions in a standard Argand burner would give 15 candle-power; but the rich local cannel coal in Scotland was capable of yielding as much as 20 or even more candle-power. Similar results could, of course, be obtained by enriching the gas by the addition of some volatile hydrocarbon.

For instance, in the "Albo-Carbon" burner the gas was caused to pass over naphthalene, which presently became volatile in the heat of the flame, and, mixing with the gas emerging from the burner, considerably improved its quality.

Somewhat better results than those mentioned above could also be obtained from the Argand burner, but this again occasioned a more delicate and unsteady flame. Yet another early improvement was in the direction of the so-called "regenerative lamps," in which the gas was caused to be heated by the flame before it passed into the burner, and a greater flame temperature and improved candle-power was obtained, as a consequence. The Wenham lamp depended on this principle.

It was, however, not until the introduction of the incandescent mantle and the Bunsen burner that any really great progress seemed possible.

The early Welsbach mantle did not answer the expectations that had been formed of it, and its commercial exploitation seemed likely to prove a complete failure until Welsbach suddenly discovered the value of the addition of a small amount of cerium, and eventually traced out the most favourable proportions of cerium and thorium which are utilized in the mantle to-day.

It had been suggested that the effect was due to pure thermal incandescence, and that the temperature

of the mantle was far hotter than that of the Bunsen flame. Again it had been supposed that catalytic action among the oxides present in the mantle took place. On the other hand, it had also been pointed out that the rare earths were peculiarly capable of showing luminescence, and that only when small impurities were present did this luminescence take place; and, lastly, it had been pointed out that the Bunsen flame was rich in the ultra-violet rays that were supposed to call this luminescence into play. All this, however, would seem to be still a matter for conjecture; one very interesting paper on this subject, in addition to the well-known Cantor Lectures of Prof. Vivian Lewes, was that by Prof. Rubens at the British Association a few years ago.

Even after this discovery, however, the mantle was far from perfect. Its luminosity deteriorated quickly, and the quality of the light was of an unpleasant greenish colour. To-day these drawbacks had been very largely removed.

Nichols, for instance, had compared mantles of the present day with old-fashioned ones as regards the colour of the light produced (see Fig. 1). The more old-fashioned mantles yielded a spectrum showing considerable selective radiation, and a corresponding

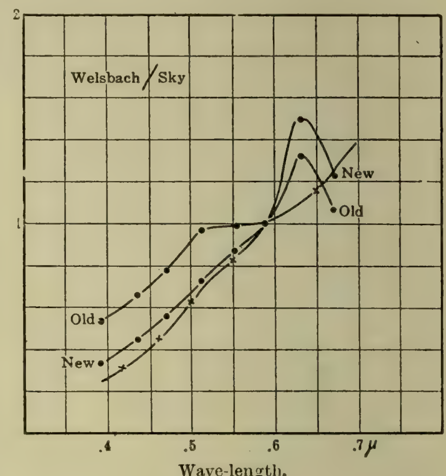


FIG. 1.—Quality of Radiation from Old and New Mantles. (Nichols.)

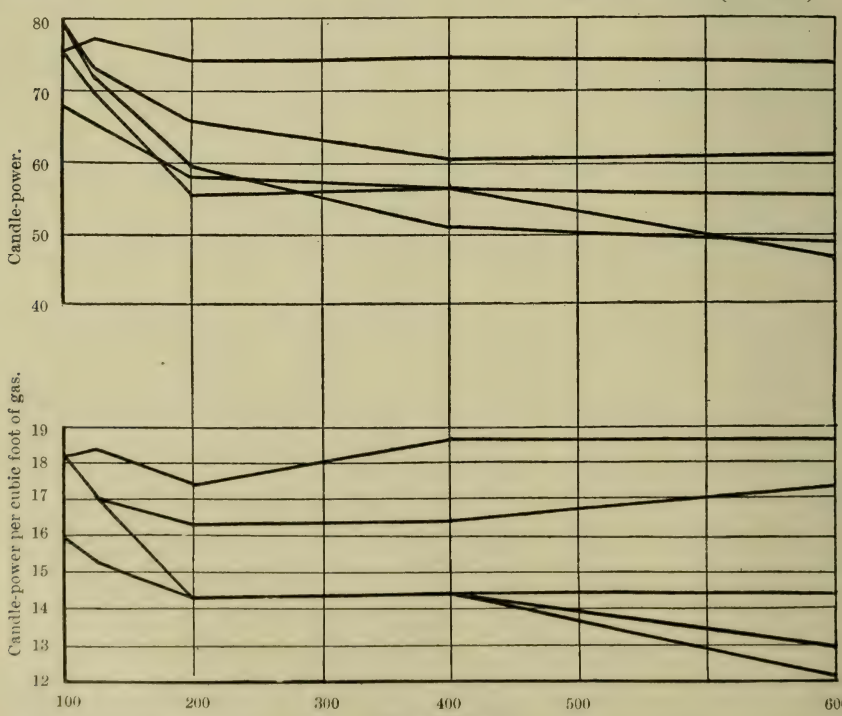


FIG. 2.—Life-curves of Incandescent Mantles. (Böhm, 1905.)

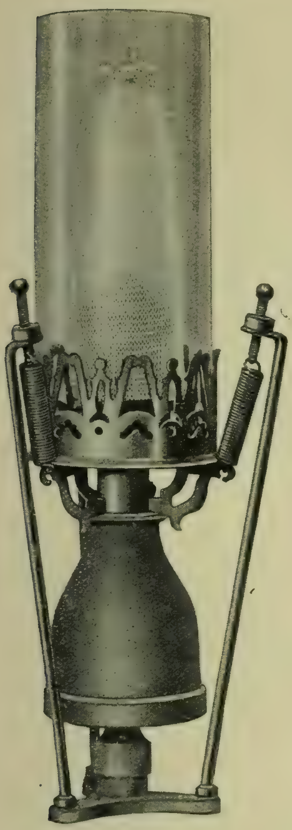


FIG. 3.—Anti-Vibration Holder (Messrs. Parkinson & Cowan, Ltd.)

deviation from daylight which is much improved in the later varieties.

While referring to the other qualities of mantles of importance, some details might be given of life tests. Fig. 2 represented some tests obtained about two years ago by Böhm (*Das Gasglühlicht*, 1905), according to which relatively efficient results could apparently even then be obtained for 300 to 600 hours of life.

As in the case of electric glow-lamps, however, one felt that—even more so perhaps in this case—practical conditions differed from laboratory tests. Makers of lamps in England at the present day found that one of their chief needs was a really good mantle, the ordinary type requiring renewal on the average every 200 hours.

For instance, the effects of even a slight vibration were very marked, though this had been reduced by the many ingenious anti-vibration devices introduced of recent years. An example of a piece of apparatus of this kind, due to Messrs. Parkinson & Cowan, was on exhibition. In addition, the results from any mantle depended very greatly on such factors as the pressure and quality of gas available, the type of chimney used, and the adjustment of the proportions of gas and air, the accumulation of dust, &c.

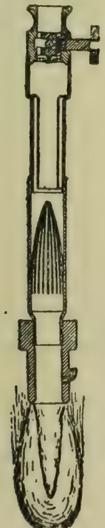


FIG. 4.—Sketch of Inverted Bunsen flame when first lighted, thermostatically controlled.

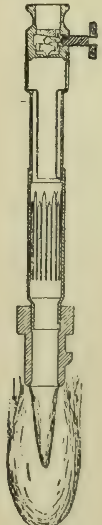


FIG. 4a.—Sketch of Inverted Bunsen Flame after burning ten minutes thermostatically controlled.

Altogether it was highly probable that the termination of life of a mantle was usually determined by breakage, rather than diminution of candle-power, just as was not infrequently found to be the case for metallic filament lamps.

The introduction of the Ramie mantle about 1898 was regarded as a great advance. More recently the Plaissetty soft non-incinerated silk mantle had attracted much attention. The distinguishing quality of these mantles was claimed to be their flexibility and greater homogeneity and durability, so that the tendency to breakage through vibration was claimed to be distinctly reduced; in addition the mantle automatically assumed the shape of the flame, and remained so during life. A number of these mantles were on exhibition.

An interesting recent development, the Hella Bushlight, consisted not of a mantle, but of a bundle of rods composed of suitable rare earths. Some examples of these ingenious mantles were on exhibition; it was claimed that their power of withstanding shock was exceptionally great.

Some reference might next be made to the development of the Bunsen burner, the other important factor in the incandescent light.

The efficiency yielded by an incandescent mantle depended very greatly on the flame temperature obtainable and the possibility of securing perfect combustion of the gas supplied. The original Bunsen burner could only be made to consume about one of gas to two of air, whereas the average town gas required about one to five and a half for complete combustion. The device introduced into the ordinary incandescent burner to avoid this possibility merely consisted of a wire gauze acting on the principle of the Davy safety lamp.

Other details in the burner had been devised for the purpose of securing intimate mixture of gas and air. For instance, in the Welsbach-Kern burner a tapering cylinder was added to the burner in order to give the gas and air opportunity of mixing completely, and a peculiar twisted head added with the object of producing a swirling motion of the mixture at the nipple.

Within the last few years a very great advance has been effected by the introduction of inverted burners. The early experiences of this burner were not entirely satisfactory, and there were many initial difficulties to overcome; so much so that even in 1906 there were many who doubted whether the burner would ever became a commercial success. For instance, the tendency to light back appeared to be accentuated, there was a tendency to produce a hissing noise, and the conduction of heat upwards to the fitting caused it to wear out very rapidly. Most of these difficulties were got over by suitable designing of the mixing chamber, &c.

FIG 5.—Hands Patent Cooled Inverted Burner.

There was also one other difficulty, namely, the fact that the burner, after burning say ten minutes, became so much hotter as a whole than originally, as to really call for slight adjustment of the proportions of gas and air in order to obtain the most perfect results, still existed.

A very ingenious method of controlling the proportions of gas and

air, and of getting over this difficulty had been described by Litle and Whitaker (*Illuminating Engineering*, vol. i. p. 333), who employed a special thermopile-controlled valve, by means of which the proportions of gas and air necessary for complete combustion were automatically regulated (see Fig. 4).

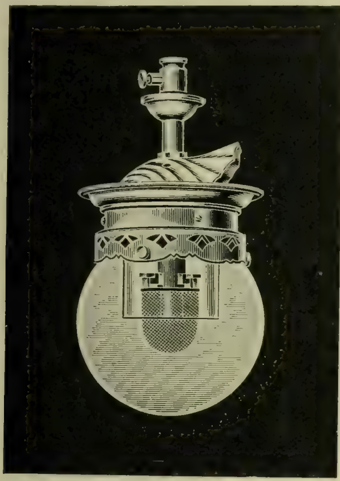


FIG. 6.—Bland Inverted Burner.

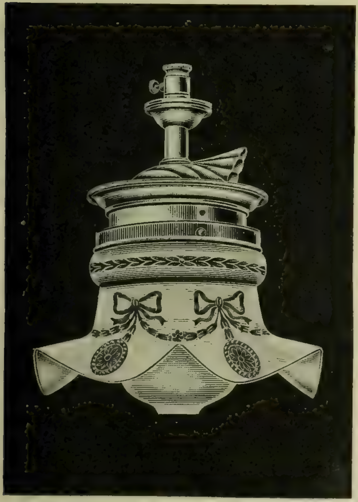


FIG. 7.—Bland Inverted Burner.

The inverted incandescent mantle, however, was of course to-day an accepted fact, and possessed very distinct merits. For instance, the attachment of the mantle by means of its entire rim was preferable to the system characteristic of the upright burner of merely hanging the mantle on a fork.

Some other examples of devices of avoiding the difficulties of inverted burners were on exhibition. For in-

FIG. 8.—Omar Inverted Burner.

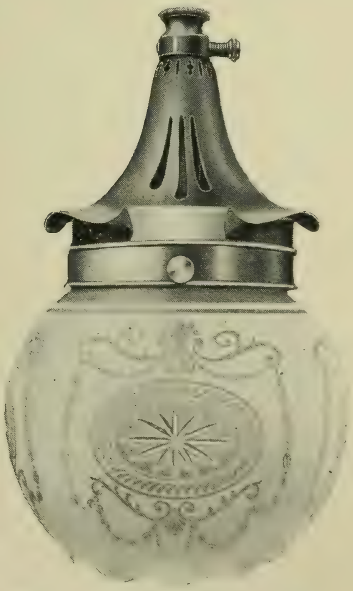


FIG. 9.—Mascot Inverted Burner.

stance, the Hands cooled burner was provided with deflecting wings intended to conduct the heat away and

prevent discolouration of the fitting; in the Bland burners again a patent anti-lighting back arrangement was provided; also a special carrier to grip and support the mantle, which was not attached to the actual burner, with, it was claimed, the result that the life of the mantle was considerably prolonged.

Two other inverted mantles on exhibition were the "Omar" and "Mascot" types of Messrs. Moffatts, Ltd.

One essential detail of these burners was an ornamental outer perforated metal casing, with which the products of combustion were not allowed to come in contact, owing to the use of an opal glass collar. It was claimed that this enabled the burner to retain its original appearance without becoming tarnished after months of use.

In the "Mascot" burner, in addition, the air was slightly warmed before reaching the mixing chamber, a good velocity of the air and gas mixture and favourable conditions of combustion being secured as a result.

One great advantage of inverted mantles lay in the improved distribution of light, the maximum candle-power being usually obtained in a downward direction. The exact nature, however, of the distribution curve depended to some extent on the shape of the burner; it was possible to obtain a good downward component, and yet to obtain as well stronger intensity at an angle downwards; this being the nature of curve we mainly desired for street lighting.

One important method of improving the efficiency of incandescent gas lighting, which had led to immense developments in recent years, was the use of high pressure, for the purpose of producing a more intimate mixture of gas and air coupled with a greater velocity of gas issuing from the burner, and therefore increased flame-temperature with more perfect combustion.

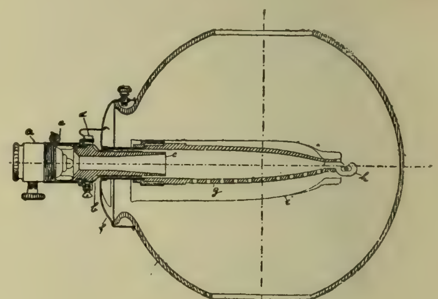


FIG. 10.—"Tubus" Horizontal Burner.

Among the many different systems of compressing the gas for subsequent use in this way, mention might be made of the Sale-Onslow, Millenium, Grätzin, Pharos, and Keith and Blackman systems.

In the latter system, of which the very latest development was shown, a very portable type of compressor was used, which was driven by electricity, water, or from a belt as might be desired.

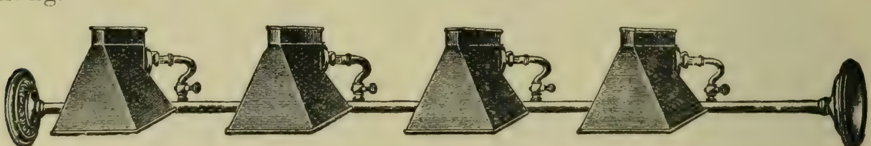


FIG. 11.—"Tubus" burners as arranged for Shop Lighting.

It might also be mentioned that the firm of Frister in Berlin manufactured a type of burner using a mantle in a horizontal position (*Illuminating Engineer*, vol. i. p. 579)—the "Tubus" burner, which was specially intended for the illumination of shop windows, where a strong downward component was desired.

The result of leading gas into the burner at a high pressure was a great gain in efficiency, and pressures up to 55 inches of water were actually in use at the present day.

The new inverted Keith lamps just installed in Fleet Street were run at a pressure of about 50 inches. For these lamps an efficiency as high as

73·6 candles per cubic foot of ordinary gas had been obtained by some experts, though only 60 was claimed. This gain in efficiency was attributed partially to the pre-heating of air and gas on their way to the burner.

A considerable amount of discussion had recently taken place round the question of the relative merits of using compressed air or compressed gas in the burner; both were capable of leading to the intimate mixture of gas and air which we desire to produce. On behalf of high-pressure air, it had been urged that the original gas pipes could be used, and in the event of anything going wrong with the high-pressure air system, the light was diminished only, and not extinguished.

When we used high-pressure gas, on the other hand, an accident to the compressor might have serious consequences, and the tendency to leakage was greater. In addition, the inconvenience of having to employ special meters for high-pressure gas, and the inconvenience of suppiying the system to private consumers, was claimed to be avoided by the use of pressure air. (For summary of this discussion see *Illuminating Engineer*, vol. i. p. 956).

This method was adopted many years ago by the United Kingdom Lighting Trust in this country, and was still in use at the present day.

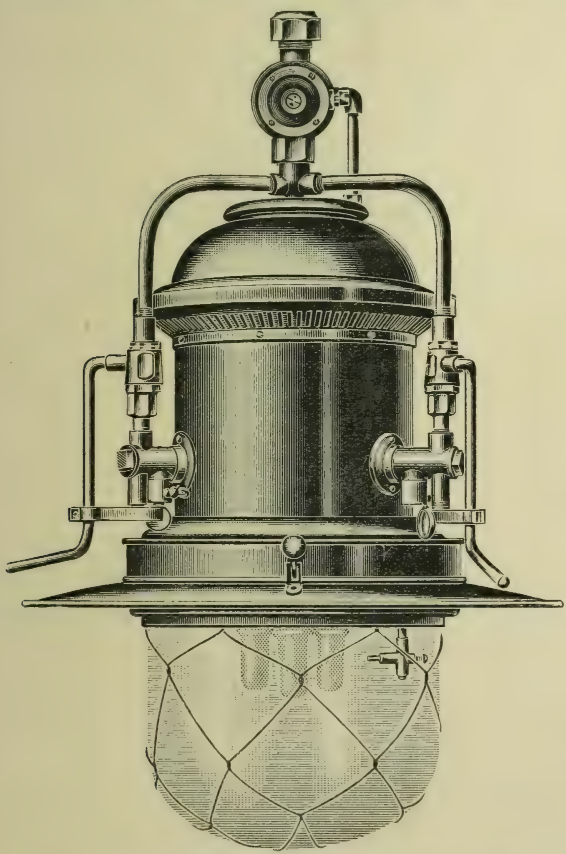


FIG. 12.—The Grätzin High Candle-power Lamp.

Another system to which reference might be made was the Selas, in which a mixture of gas and air in the proportion of two to one was compressed at 10 inches, and supplied to the burner. A very intimate mixture was claimed to be secured, and good results could be obtained with a great range of

burners. Attempts had also been made to introduce into ordinary gas lamps local pressure raising or regenerative devices, so that they could be run from an ordinary gas supply. Thus Scott-Snell many years ago devised means of pre-heating the air supplied to the burner and securing a forced draft. Lucas sought to produce an increased draft by the use of special long chimneys, but this simple device rendered the lamp rather long. More recently, Lucas had introduced the ingenious application of a thermopile, the junction of which was placed near the flame and supplied current to a small electrically driven fan at the base of the lamp; a recent improvement consists in a device to enable the junction to get heated without being actually in the hot zone of the flame. It was stated that the thermopile will last 1,000 hours before it requires renewal.

The lamp was said to yield 1,200 c.p. with a gas-consumption of 33 cubit feet per hour.

Yet another type of portable high-pressure lamp was the Chipperfield, utilizing a small hot-air engine placed above the burner, which automatically pumped air under pressure into the heated reservoir, and the combination of increased pressure and pre-heating resulted in a considerable increase in efficiency.

Some published tests on this lamp attributed to the lamp an efficiency of about 30 candle-power per cubic foot

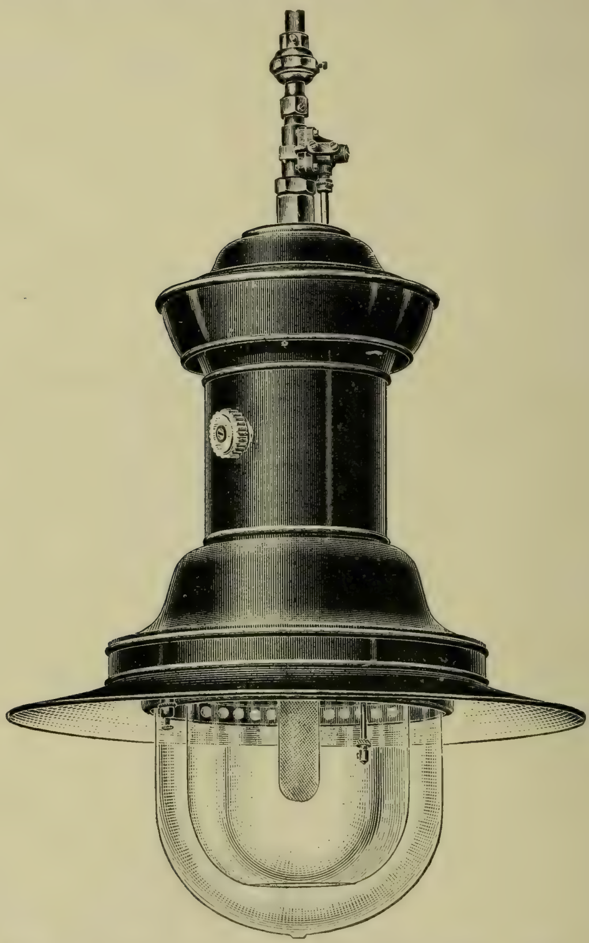


Fig. 13.—Keith 1,500 Candle-power High Pressure Lamp.

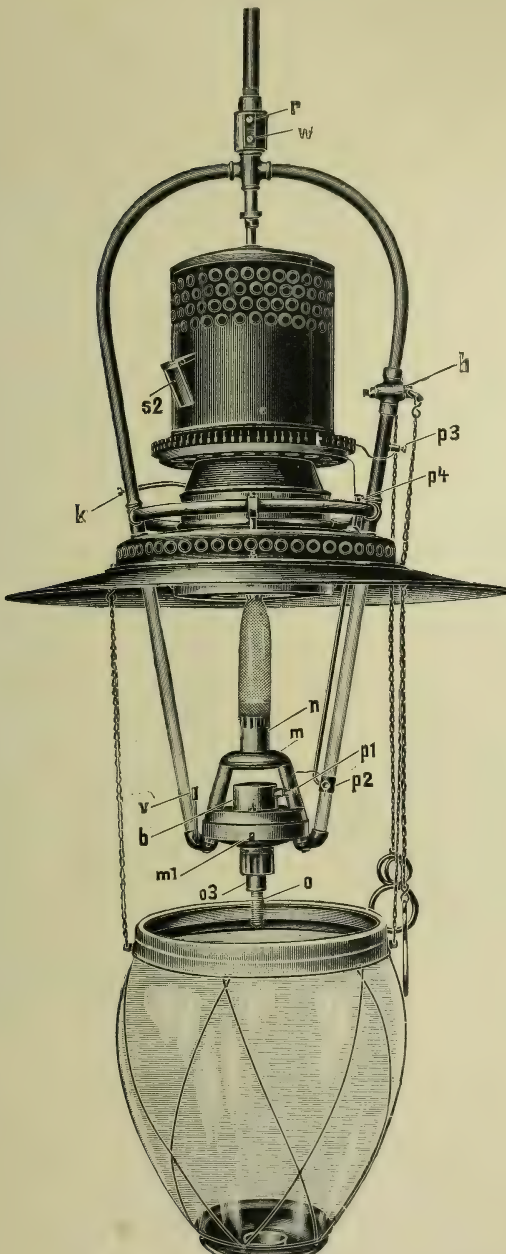


Fig. 14.—Details of Lucas Thermopile Lamp.

[The gas enters through the regulator at *r*, passes through the cock *h* into the mixing chamber *m*, and finally through the burner at *n*, and so, after heating the mantle, up the chimney. In this is fixed the thermopile *t*, the current generated in which is carried by the wires p_1, p_2, p_3, p_4, to *m*, a small electro-motor, rotating about a vertical axis at a speed of 2,000 revolutions a minute. This motor is coupled directly on to a small fan, which creates the required draught.]

of gas. It was understood, however, that an inverted lamp was being experimented upon for which improved efficiency was expected.

A few words were said regarding a system of gas lighting which has recently come into prominence, namely, the use of liquid gas of various kinds, such as the Wolff gas. Compressed gas of this description was mainly employed in cases in which portability is extremely desirable, for lighting railway carriages, &c.; this subject,

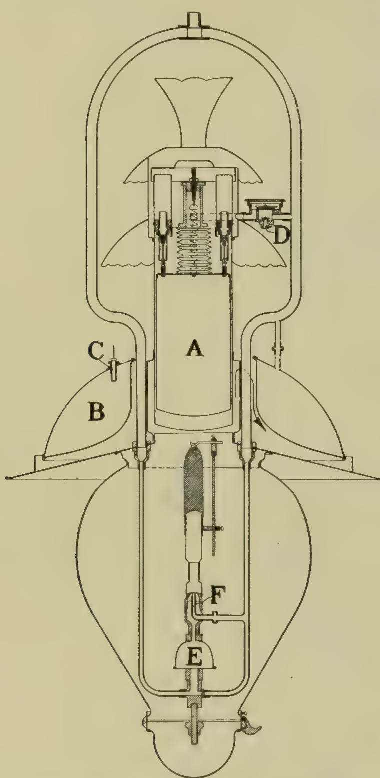


FIG. 15.—The Chipperfield Lamp.

however, would be dealt with in the next lecture.

One development in gas lighting which would be recognized to be of exceptional importance at the present day was the question of automatic ignition. If there was one respect in which electricity had claimed to possess the advantage of gas lighting more than another, it was in the ease with which electric lamps were lighted or extinguished. Naturally, therefore, efforts had been made to extend the same facilities to gas lighting.

One of the simplest systems was that illustrated by the "Norwich" method, exhibited by Messrs. J. Hands & Co., in which the actual gas-pressure controlled a valve applied to the nose-piece of the fitting. The manipulation of the switch inserted in the pipe provided either a bye-pass or allowed the gas to flow freely to the burner; the system was claimed to be a very permanent one, only requiring occasional trifling attention. (See Fig. 19.)

Systems of electrical and other

FIG. 16.—Self-lighting Mantle (J. Mayer).

methods of ignition formed the subject of a valuable paper by Mr. T. J. Litle, at the Second Annual Convention of the Illuminating Engineering Society (*Illuminating Engineer*, vol. i. 1908, p. 1025). Several systems used air-pressure to control the valve at a distance. They had, however, their limitations.

It was stated by Mr. Litle that the ordinary pneumatic system was not usually applied to ignition at distances of more than 20 yards, which was, of course, amply sufficient for an ordinary household, though special pressure-raising devices might be used to act

on a lamp in a very large hall. Of course, the pneumatic systems presupposed the use of a pilot flame.

Another method that had been the subject of a considerable amount of experiment was the electrical ignition. According to the usual system the kindling is accomplished by a jump spark or an induction coil or magnetic generator. At the discussion of the paper by Mr. Litle referred to, many divergent expressions of opinion were to be noted, some professing to have found the system completely unsatisfactory, while others found it very irregular; this was one of those cases in which the gas engineer had found it to his advantage to study the kindred subject of electricity. In the discussion of Mr. Litle's paper it was very generally agreed that previous failures had been largely due to deficient insulation.

By the courtesy of Mr. George Keith the lecturer was able to show the automatic electrical ignition by means of a heated platinum wire used with the newest Keith lamps, which was, he believed, exhibited in public now for the first time.

Mention might also be made of various attempts to produce some apparatus which should be absolutely self-lighting. It had long been known, for instance, that spongy platinum, and other substances, when exposed to a stream of gas, became heated and might serve to kindle the latter into a flame. Unfortunately, the heat of the flame tended soon to injure this quality. For this reason a device was adopted by means of which as soon as the flame was lighted by the heated mass, the spongy material should fly out of the flame. Even thus, however, it soon deteriorated owing to the effect of atmospheric moisture, &c., and other causes.

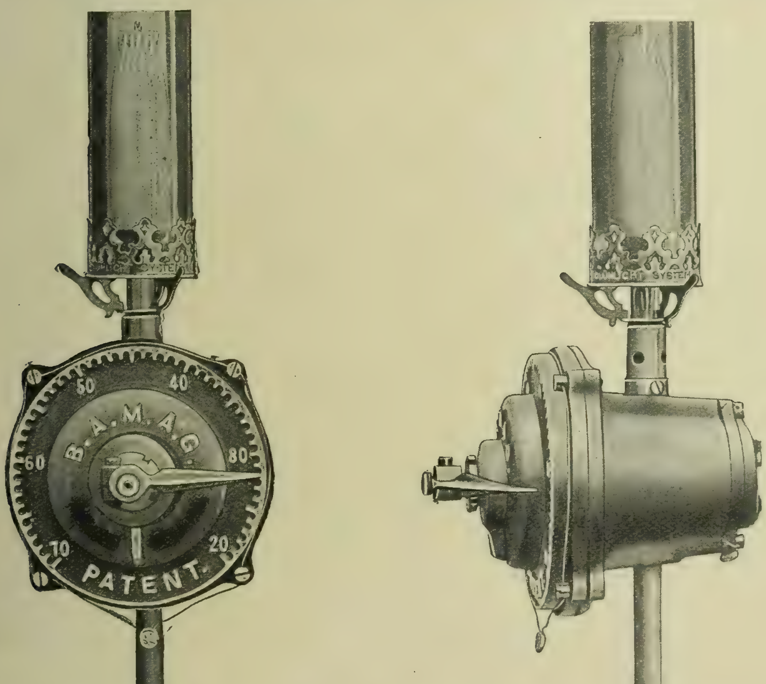


FIG 17.—The Bamag Automatic Distance-Lighting and Extinguishing Apparatus.

One of the newest types of self-lighting gas mantles of this kind, due to J. Mayer, was exhibited which was said to be exceptionally permanent (see Fig. 14.)

Several pellets of a special compound similar to platinum, black in appearance, were attached to the top of the

mantle, a certain chemical composition, painted on the mantle in the form of red stripes leading to the black compound, serving as a preliminary heater. After the gas was turned on these stripes first began to glow and then communicated their heat to the pellet, which in turn ignited the escaping gas.

It was, however, hardly needful to point out that any automatic system intended for use in interiors must be absolutely reliable.

A very wide field for automatic distance-control had recently been opened out for public street lighting, which now formed an essential portion of the revenue of gas works. Electric public lighting claimed a big advantage in being able to control all lights from one point, and it was very desirable, in the interests of the public, to enable all gas lamps to be switched on and off in a similar manner, so as to meet the climatic and meteorological conditions. Therefore special pieces of apparatus had been designed utilizing either waves of pressure, clockwork control, or electrical ignition systems.

Some seven years ago experiments in this direction were undertaken, and had resulted in several forms of pressure distance lighters, acting with diaphragms or floats respectively.

As an example of the diaphragm method, he had the privilege of exhibiting the Bamag system that was very extensively used on the Continent, as well as in this country. In this device it was possible to definitely regulate the exact increase in pressure in the mains that was necessary in order to cause the burner to light up, and this adjustment was made by merely setting the pointer at the desired pressure. The apparatus had the advantage of being controllable either by a rise or fall of pressure.

Another well-known and interesting pressure automatic lighting and extinguishing apparatus for street lamps was that of Dr. Rostin.

In this apparatus there were two distinct parts, one more or less similar to any other device on the market and a second part consisting of special liquid valves. These served to admit the pressure of gas to the first-named or open an exhaust out of it.

To this second part the success of the apparatus was due; the valve arrangement acted as a kind of regulator and allowed the pressure to work the apparatus only when required, involuntary variations of pressure passing by without affecting the apparatus. This appliance was also distinguished by the using of a proper cock instead of small valves for the admission of gas to the burner.

The two valves floated in a special non-freezing and non-evaporating mixture of glycerine and water, an increase in pressure up to thirty-five tenths, having the effect of admitting the gas and turning on a main cock. It might be remarked that the valves in this case had no actual work to do, and no friction to overcome, and therefore should work quite correctly, the actual pressure on the cock being accomplished by the gas.

Clockwork systems, controlling street lighting, by which the lamps were turned out and lighted at a pre-determined hour, had also been utilized very frequently. These methods had certain advantages, being very reliable.

On the other hand, they had the disadvantage of being, in a sense, *too* automatic; they turned on and off the light at a certain hour, but on an exceptional occasion, for instance, when a fog was on, they, of course, would not take account of the fact, whereas an instrument controlled from the station could be made to do exactly what was wanted. Such clockwork methods had also found a field for advertising signs, which could be left burning on the premises without the shop keeper or his assistant being actually there.

Really, the best method of distance-lighting to adopt depended on the requirements of the district; it was, however, desirable that any such apparatus should not prevent the lights being attended by hand in an emergency

A few words were next said on the subject of street lighting, reference being made to the lighting by high-pressure inverted mantles in London

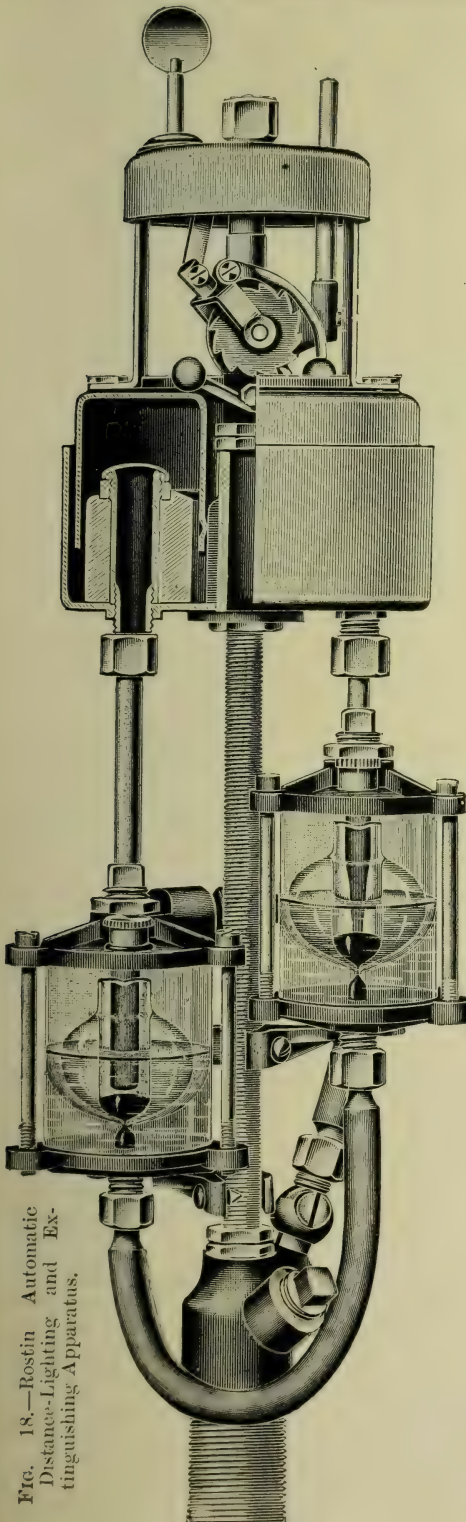


FIG. 18.—Rostin Automatic Distance-Lighting and Extinguishing Apparatus.

and Berlin. A new method of attaching the lamps to the houses, instead of at the top of lamp posts in the customary manner, had been adopted in Fleet Street. At the same time it was interesting to observe that the method of stringing electrical arc-lamps on wires spanning the street had been employed in Cannon Street. This method had previously been used in the Friedrich Strasse in Berlin.

Mention was made of the researches of Mr. A. A. Voysey in London (*Illuminating Engineer*, vol. i. p. 56, 1908) and Dr. L. Bloch in Berlin; whatever views might be taken as to the correctness of the results obtained, it was satisfactory to observe that the comparison of different methods of lighting now tended to be used on actual photometrical measurements.

In conclusion, the lecturer dealt with a few general questions of interest at the present moment, notably the problem whether it was desirable or possible to replace our present method of testing gas for illuminating value, by a calorific test. It was pointed out that the granting of permission to London Gas companies to reduce their candle-power from 16 to 14, and the decision of the Edinburgh and Leith Gas Commissioners to reduce the candle-power of that town from 20 to 14, were illustrations of the prevalent tendency.

Reference was also made to the attitude of gas companies towards the consumer, which had undergone a marked modification in recent years. It was now realized that the company ought to do all that was possible to help their customers; and some of the London gas companies now undertook the supervision of their installations at a small fee. For instance, the Gaslight and Coke Co. adjusted the burners of a large number of consumers, and renewed as many as 200,000 mantles in the course of the year. Customers, however, frequently learnt sufficient of the art of making their own adjustments to lead them to eventually decide to do without the company's assistance. In this way, the company did invaluable educational work. Their action in selecting and testing the type of burners supplied to the con-

sumer by a rigid specification was also an important development.

In referring to the great progress that had recently taken place in the gas industry, the lecturer alluded to the loss the industry had sustained during the past year in the passing away of Sir George Livesey, and expressed his warm approval of the method adopted of honouring his memory by creating a special professorship at Leeds University. No doubt the subject of illuminating engineering would receive the attention it deserved. He hoped that these facilities would be taken advantage of by the young members of the profession, and that manufacturers would recognize the duty of encouraging, by suitable means, students who had taken the pains to educate themselves in this way.

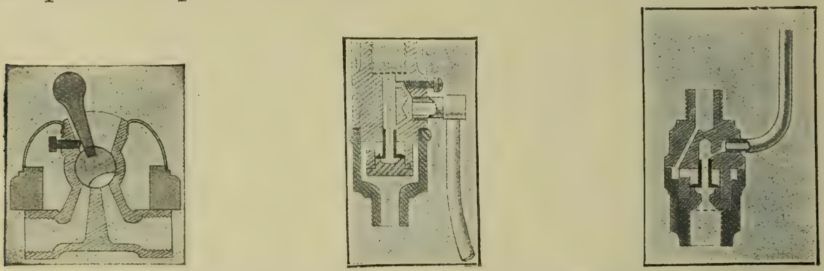


FIG. 19.—Details of the Norwich Distance-Lighting System.

SECOND LECTURE, FEB. 22ND, 1909.

Thanks are also due to the following firms who have exhibited at this lecture:—

High Candle-Power Lamps.

The Chipperfield Lamp Syndicate, Limited. — The Chipperfield self-intensifying lamp.

Messrs. R. Frister & Co. (Oberschöneweide, Berlin).—Example of the "Tubus" horizontal type of incandescent burner.

Messrs. Keith & Blackman, Ltd.—Complete model plant, comprising an electric motor and compressor to light the lamps exhibited, viz., one 1,500 candle-power high-pressure lamp, one 500 candle-power ditto, and one 150 candle-power ditto, fitted with automatic electric control and electric ignition.

Messrs. Moffat, Limited. — The Lucas thermopile self-intensifying lamp.

Messrs. J. and W. B. Smith. — The Grätzin high-pressure lamp, 3 burners type, 4,500 candle-power; and the latest model compressing plant, comprising gas engine and compressor suitably mounted for exhibition.

New Types of Mantles and Burners.

Messrs. Bland & Co.—Bland inverted burners.

Messrs. Falk & Stadelmann, Ltd.—The Vesta-Gratzin burners.

Messrs. G. Hands & Co.—The Hands patent cool inverted burner

F. Mayer.—Self-lighting mantles.

Messrs. Moffat, Limited.—"Mascot" and "Omar" inverted burners.

The Plaissetty Manufacturing Co., Limited.—Various types of Monarch and other soft mantles.

The Herbert Tuchman Manufacturing Co.—"Reflex" inverted burners, small and larger types.

The Universal Gas Methane and Hella-Bushlight Co. — Examples of the Hella bushlight.

Automatic Ignition Systems.

The Bland Light Syndicate, Ltd.—Pneumatic distance control.

Messrs. G. Hands & Co. — The Norwich system.

Schweiz. Flussiggas Fabrik L. Wolf, A.-G.—The Wolff liquid-gas apparatus.

Messrs. Parkinson & Cowan, Ltd.—Exhibited an anti-vibrating device.

The Distance Lighting Co. showed the Bamag distance pressure-lighter and extinguisher for street lamps; and **Messrs. A. Landsberger** and **Dr. Rostin** exhibited the Rostin apparatus for the automatic control of public lights at a distance.

Special thanks must also be given to **Mr. F. W. Goodenough** and the **Gas Light and Coke Co.** for kindly putting at the lecturer's disposal the services of several fitters from the company's premises, and thus enabling the requisite piping for the exhibits to be laid at very short notice.

III.—Oil, Acetylene, Petrol-Air Gas, and other portable Systems of Lighting.

By Leon Gaster.

Cantor Lecture delivered before the Royal Society of Arts, on March 1st; the following abstract is made by kind permission of the Society.)

The two first lectures, Mr. Gaster remarked, had dealt with gas and electric lighting. He now proposed to deal with systems of lighting which naturally lacked some of the advantages associated with these highly developed methods, but yet had themselves certain advantages, and notably those of portability and of being self-contained, and independent of a supply of fuel from without.

It had, indeed, been shrewdly remarked that were the candle and oil lamp to be invented for the first time in the present age they would be hailed by people only acquainted with gas and electric lighting as marvellous inventions on account of this very portable quality. Therefore the oil lamp, and such methods of lighting, deserved at the present day very careful consideration for there was still a wide field in which they might expect to prove very serviceable.

Dishes of liquid oil and fat were employed even by the most ancient nations; they were used mainly for purposes of ornament rather than for the purpose of providing actual illumination. Indeed this use of the oil lamp prevailed in many churches at the present day. The lighting of the Church of Santa Sophia in Constantinople, which Mr. J. B. Fulton had recently described in *The Illuminating Engineer* (vol. ii. Jan., 1909) was an illustration.

Candles, too, were still very frequently employed for decorative purposes, and for the religious and other associations connected with them. For instance, when the lighting of the Bevis Marks Synagogue, the oldest in this country, was under consideration during the bi-centenary celebrations a few years ago, the authorities decided to retain the exact original arrangements which are moulded on those of the celebrated Amsterdam synagogue.

Oil-Lighting.

The discovery of oil in America about 1860 led to the development of the petroleum lamp proper.

The ordinary petroleum lamp was often unjustifiably condemned for certain defects which were not inherent in it, and could be avoided by suitable design. In country districts lamps were still so widely used that there was room for the careful study of the best methods of distributing and utilizing the light produced, even at the present day. This matter formed the subject of discussion at the International Petroleum Congress held at Bucharest in 1907, when papers were presented by M. Aug. Pihan, Herr Proessdorf, and the speaker (*Illuminating Engineer*, Vol. I., January, 1908, p. 79). A resolution was taken after the latter lecture that the Congress should study and decide upon a type of domestic lamp having the conditions of greatest safety and highest efficiency.

This question of safety indeed was a very vital one to the success of oil lamps.

It might also be pointed out that the design of any particular lamp must take into account the nature of the petroleum which was intended to be used with it. For instance, a lamp intended for American oil would probably not be so satisfactory for use with the Russian variety.

Recognizing this fact the Roumanian Government had last year, for the first time, introduced legislation specifying the exact conditions to be fulfilled by oil used for illuminating purposes in that country.

M. Pihan, on this and other occasions had prepared details as to the correct method of testing oil lamps, and the paper by Herr Proessdorf, in which 150 lamps were examined, was a useful record of research on lamps burning different kinds of petroleum.

A very interesting point was recently touched upon by M. Guiselin (*Illuminating Engineer*, vol. i. March, 1908), who demonstrated how greatly the light from an oil lamp was affected by the quantity of oil in the reservoir. An increase of 20 per cent in the illuminating efficiency could be secured by keeping 700 c.c. of petroleum in the reservoir, instead of 500. This was due to the assistance given to the capillary action of the wick, by the higher level. Consumers were therefore recommended to keep their lamps well filled up.

The coming of the incandescent burner suggested a new method of utilizing liquid fuels. It was soon realized that if a liquid illuminant could be vapourized and mixed with the correct proportions of air, it might be utilized to heat an incandescent mantle. One of the earliest methods of utilizing petroleum in this way was the Kitson system, according to which petroleum was compressed at about 50 lb. to the square inch in a suitable vessel, forced through a soft brass tube of very small bore into a heating chamber, and subsequently through a needle orifice to a suitably designed Bunsen burner. This system had found a considerable field for lighthouse illumination, and in other cases where big units are essential.

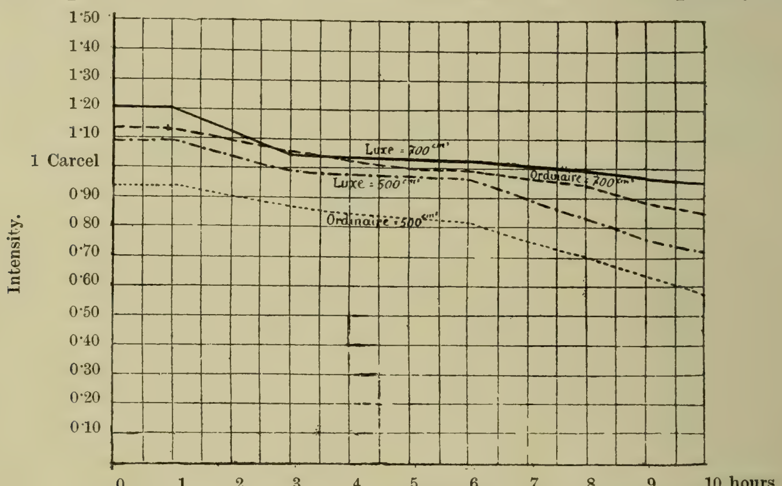


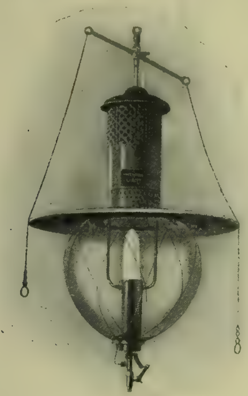
FIG. 1.—Curves illustrating improvement in Light obtained from Oil-Lamps by keeping higher level of Petroleum in the Reservoir (Guiselin, *Illuminating Engineer*, March, 1908).

Some very complete researches on the oil lamp as a standard, were communicated by Dr. A. H. Elliott at the second Annual Convention of the Illuminating Engineering Society last year. In the discussion the importance of careful attention to the wick was dwelt upon, one of the speakers referring to a new non-combustible asbestos type. A variety of non-combustible wick due to Dr. B. Monasch, and composed mainly of carborundum had recently been devised. This same authority had recently contributed a study of the ordinary kitchen oil lamp, and had pointed out that the reflector commonly provided with these lamps was of very little service (*Jour. of Gas.*, January 25, February 1 and 8, 1908).

The most recent example of the Kitson system, the Empire lamp sold in England by the United Kingdom Lighting Trust, was an entirely portable self-contained lamp, in which an improvement was introduced by arranging the heating vessel in a vertical position quite close to the burner instead of above it.

The Blanchard system again utilized paraffin in a form of self-contained lamp equipped with an inverted mantle, a special feature being the existence of a second vapouring chamber in which the heavier fractions

of the oil could fall and be vapourized by their close connexion with the mantle itself. The use of an inverted burner, it was claimed, also enabled small units to be supplied with greater ease, lamps yielding from 75 to 1,200 candle-power being available. An ingenious and interesting device used in this lamp was the method of registering the level of liquid in the vapourizer which must be entirely closed and so adjusted as to withstand many times the pressure which it is likely to experience. This consisted of a magnetic needle on the outside of the vessel, which was controlled by a magnetic float rising and falling on the liquid within. Such lamps were said to burn 20 hours without requiring attention. Portable table lamps of this kind were also available and on exhibition.



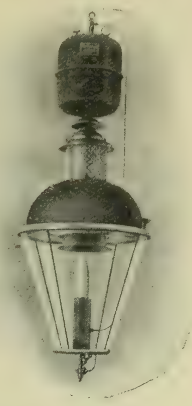


FIG. 2.—Forms of Incandescent Oil Lights (The Empire Light).

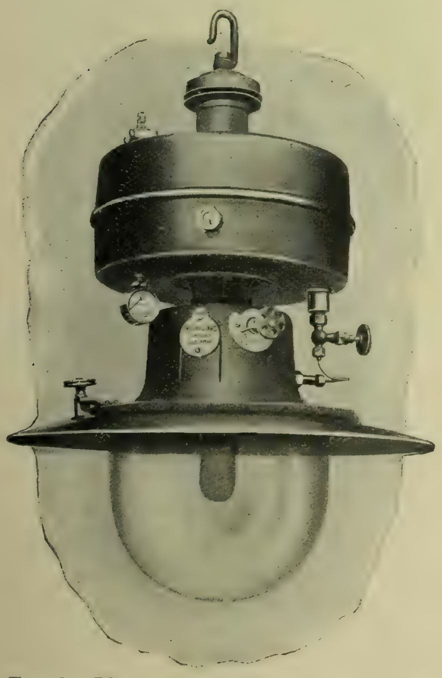


FIG. 3.—Blanchard Lamp, Commercial Form.

Another ingenious method of applying vapourized hydro-carbon was exemplified by the Petrolite lamp, an example of which was also on exhibition. In this lamp air was sucked through a porous vessel impregnated with suitable hydro-carbons, a draught being provided by the use of a fairly long chimney. One advantage claimed for this lamp was its safety. For, if the lamp was over-turned and the chimney broken or displaced, the draught ceased, and with it the generation of inflammable vapour, and the lamp therefore went out. Another portable lamp referred to was the "Lucisca" of Messrs. Falk, Stadelmann & Co.

PETROL-AIR GAS.

A considerable amount of interest had been aroused of late in methods known as "Petrol-Air Systems." They all depended on the generation of a mixture of petrol-vapour with air in suitable proportions, the air being passed through suitable vessels and carburetted by the illuminating vapour.

The machine by which this is accomplished usually consists of a small hot-air engine, operated by the gas which

FIG. 4.—Blanchard Portable Table Lamps.

it produces, together with a suitable blower, carburetter, and gas-holder; in some cases the motive power was supplied by a falling weight, which was newly wound up from time to time, or, where available, waterpower.

Such machines were designed with a view to being as easily controlled and as automatic as possible; once the engine was started, which should only take a few minutes, the apparatus, it was claimed, ought to continue its functions automatically.

Briefly, the main essential quality of all systems was that the mixture generated at the burner should have a proportion of about $1\frac{1}{2}$ of petroleum vapour to $98\frac{1}{2}$ of air, and that the composition of this mixture should be automatically maintained constant.

Naturally the burners using such air-gas had usually to be of special design, and relatively small incandescent mantles were used.

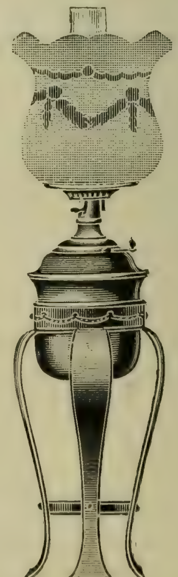


FIG. 5.—The Petrolite Lamp.

One difficulty which the system had had to contend against in the past had been the condensation of liquid in the pipes. The best modern systems, however, claimed to have completely avoided this difficulty by suitable design.

The lecturer then proceeded to refer to the different systems on exhibition, remarking that it was naturally impossible to deal with them in detail, but that he intended to do so more fully in the published account in the transactions of the Society.

A complete working plant of the National Air Gas Co. (Glascoe's system), supplying gas to a series of incandescent burners, was shown. This method only utilized about $1\frac{1}{2}$ per cent of petrol vapour, special arrangements being made to secure a gas of constant composition with varying load. A special thermostatic control of the admission of gas and air, and a relief valve by the aid of which the air was allowed to escape when not actually required for the production of gas, were features of the system.

In addition, the introduction of heat, also automatically controlled, is said to enable that lost in vaporization to be efficiently replaced, rendering it possible to use a low grade spirit that is both cheaper and safer than the variety that would otherwise have to be employed.

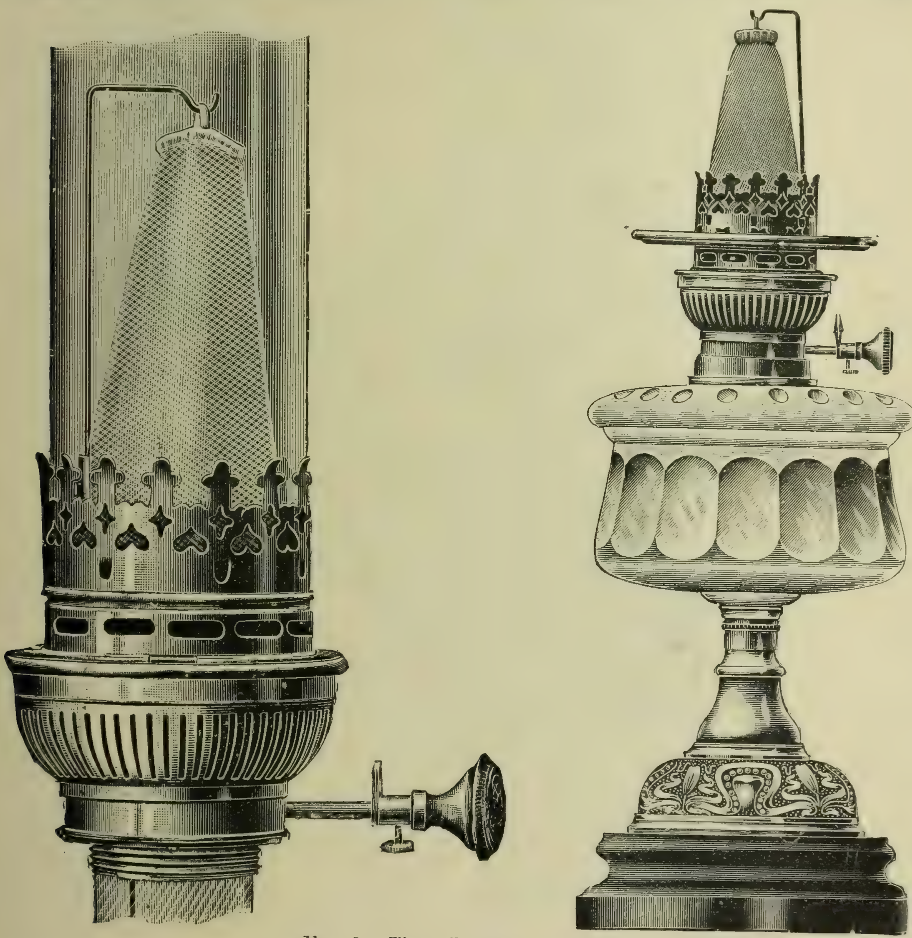


Fig. 6.—The "Lucisca" Lamp.

The Aerogen system (exhibited by Messrs. Strode & Co.) produced a gas mixture of about 5 per cent of petrol vapour only, and this percentage was

maintained automatically by the mechanism under all conditions. The automatic feeding secured that the amount of petrol introduced into the carburetter was in exact proportion to the amount of air, and a uniform mixture was produced, the machine regulating its speed as more or less gas was consumed, and stopping altogether if no gas was required. It was stated that an even temperature was always maintained, so that freezing due to evaporation was completely avoided. It was also claimed that only very small pipes were needed to convey gas of this nature to the burners, and that the additional air drawn in had a cooling effect at the

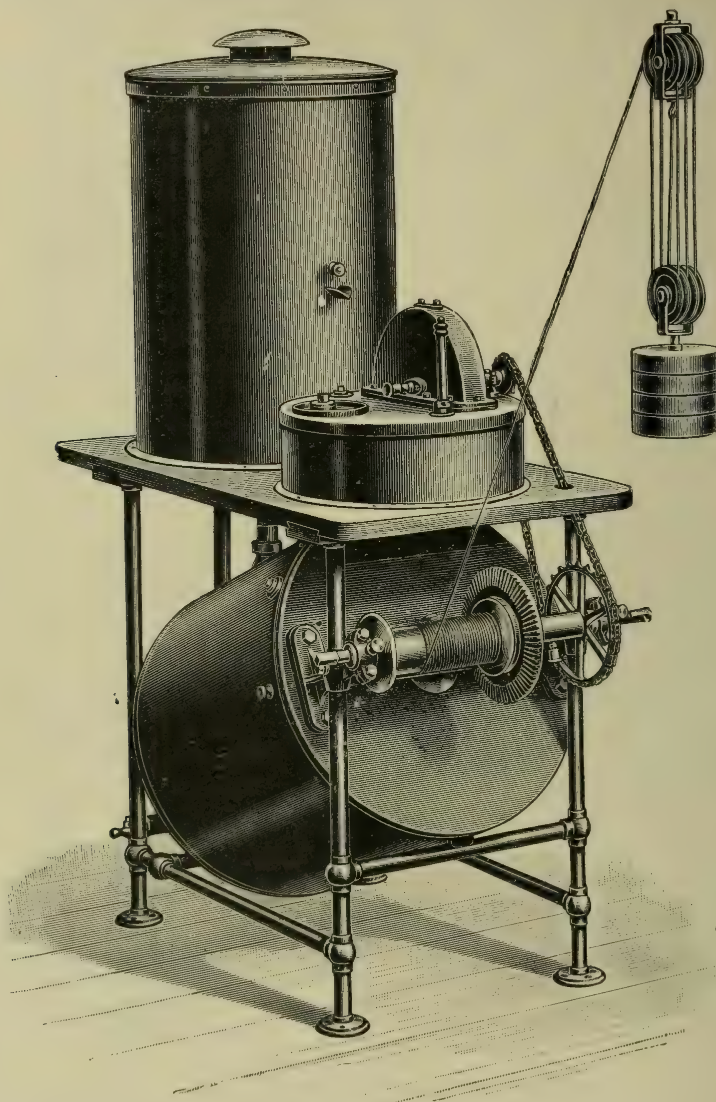


Fig. 7.—The Aerogen Air-Gas Apparatus (Messrs. Strode & Co.)

burners, and enabled them to last longer than would be the case with gas of a poorer quality.

Yet another system shown in actual oepration was that of the Machine Gas Syndicate (Cox's system), which pro-

duced a mixture of gas and air in the proportions of 1·4 to 98·6; for this system it was claimed that that enabled a very dry mixture to be obtained, the design of the carburettor being such as to generate gas that did not condense even under the most unfavourable conditions. As an illustration of this quality the mixture actually supplied to a series of incandescent burners, was passed through a coil of pipes immersed in a freezing mixture, and yet, as could be demonstrated by turning on the taps beneath, no vapour was condensed during the time the apparatus was on exhibit.

co-operate and erect a common air-gas generator, anticipating that the result would be cheaper than the local gas supply. Most systems of petrol-air gas claimed to be exceedingly cheap in operation, it being often maintained that the actual running costs were between 1*d.* and 2*d.* per 1,000 candle-power hours.

The fire insurance companies insisted upon the actual plant containing the petrol being installed outside the house; it was therefore obviously desirable to utilize a form of generator which should be absolutely automatic, and should not require attention at

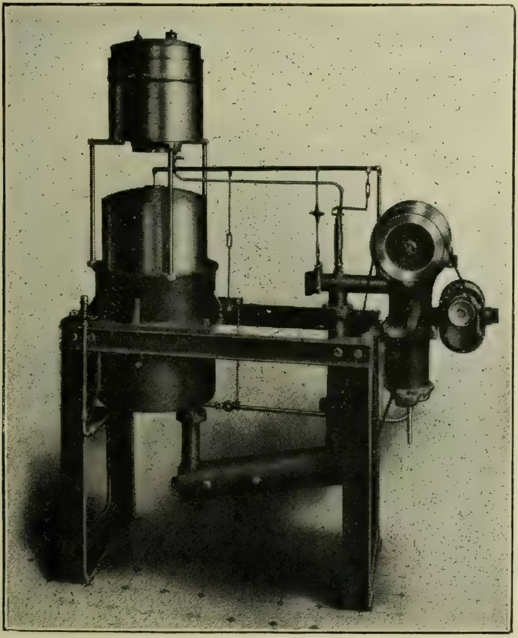


FIG. 8.—Cox's Air-gas System (The Machine Gas Syndicate.)

Naturally the lecturer had only been able to refer to a few examples, representative of the many different systems upon the market. In addition, however, he might mention the De Laitte, Praed, Litz, Mitchellite, Loco, &c., though this did not by any means exhaust the types available.

Petrol-air systems were intended mainly for use in remote country districts where gas and electricity were not available; however, an interesting development had recently taken place in Romford, where a number of adjacent shopkeepers had proposed to

too frequent intervals.

The actual gaseous mixture in the pipes was admitted to be usually of such a composition as to render it almost impossible for an explosion to occur, and the smell of escaping gas though distinct was stated not to be unpleasant. In the case of such gases as ordinary town gas and acetylene on the other hand, it must, of course, be admitted that the production of an explosive mixture, owing to an escape, is at least a possibility, though avoidable by good workmanship.

Alcohol, and Other Methods of Incandescent Lighting.

The lecturer next proceeded to make brief reference to systems of alcohol incandescent lighting. Unlike petrol and petroleum, which contained a somewhat uncertain variety of various hydro-carbons of different specific gravity, it had a constant composition. This, theoretically, should make it easier to produce a perfect type of burner, and complete combustion. In addition, while alcohol was admittedly a somewhat inflammable liquid it had the property of mixing with water, and was therefore readily extinguished by a water douch. In many countries where there was no natural oil supply, the agricultural industries made it an easy matter to secure a supply of alcohol for purposes of illumination. One matter requiring consideration, of course, was the question of suitable adulteration of the alcohol so as to render it unfit for human consumption.

Some attention was next devoted to the use of various other systems of liquid fuels, which had been found of considerable value for lighting railway carriages, &c., and in other cases where portability is extremely desirable. In these systems various hydro-carbons were frequently liquified under considerable pressure, stored in cylinders, and might then be carried about to any particular destination. One of the oldest in this country was the Pintsch oil-gas system in which oil-gas was subjected to a pressure of 6 to 7 atmospheres per square inch.

Blau gas, again, was a special liquid illuminating gas produced by distillation of mineral oils, such as crude petroleum. This gas was compressed at the exceptionally high pressure of 100 atmospheres.

Yet another system of a kindred nature was the Wolf gas (*Illuminating Engineer*, vol. i. 1908, p. 681), which, through the kindness of Dr. Achner, was on exhibition. This gas consists mainly of such hydro-carbons as ethylene and ethane, and was claimed to be influenced to an exceptionally small extent by external temperature.

Most of these gases have been rendered much more useful by the coming of the incandescent mantle, and some of them were credited with an exceptionally high calorific value, leading to a high efficiency in the burner.

Acetylene.

The lecturer now turned to acetylene. This method of lighting had only been developed to perfection in the face of many early difficulties.

Nowadays very careful purification had removed many of these defects; to-day it was possible to burn acetylene without smell, and it was said that acetylene itself could be rendered absolutely odourless were it not for the danger attaching to such a gas, which would, of course, be liable to escape detection in the event of a leak.

It was at one time the subject of discussion whether the carbide should be allowed to fall into water, or whether water should be allowed to drop on to the carbide; the former method seemed to have been eventually decided to be preferable, as the tendency to rise in temperature was less. More recently quite a number of ingenious improvements had been introduced, one method the "Brikettide" system, utilizing briquettes composed of granular carbide compressed into cakes with some inactive binding material; for these briquettes it was claimed that they were not hygroscopic, and therefore did not deteriorate in quality with time and storage; also that they almost immediately cease to evolve acetylene when withdrawn from the water; the inconvenient tendency towards "after gasing," which resulted in the accumulation and ultimate escape of gas when the generator was turned off, was thus claimed to be avoided. Similar efforts in this direction had previously been made. For instance, the carbide was compressed into cakes and coated with paraffin or sugar.

Just in the same way improved design of acetylene burners had removed many of the early troubles to a great extent, and notably in the direction of avoiding their tendency to become choked up. One cause for

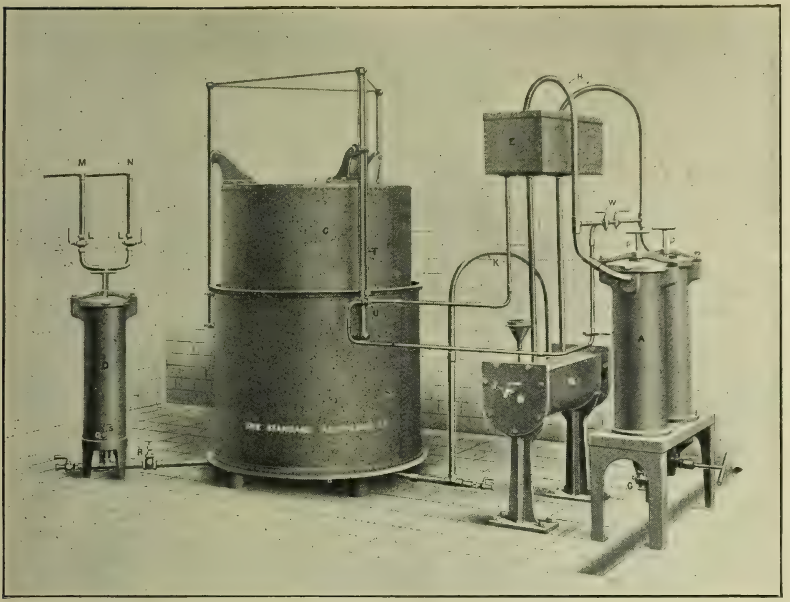


FIG 10.—Automatic Acetylene Gas Plant (The Standard Acetylene Co.).

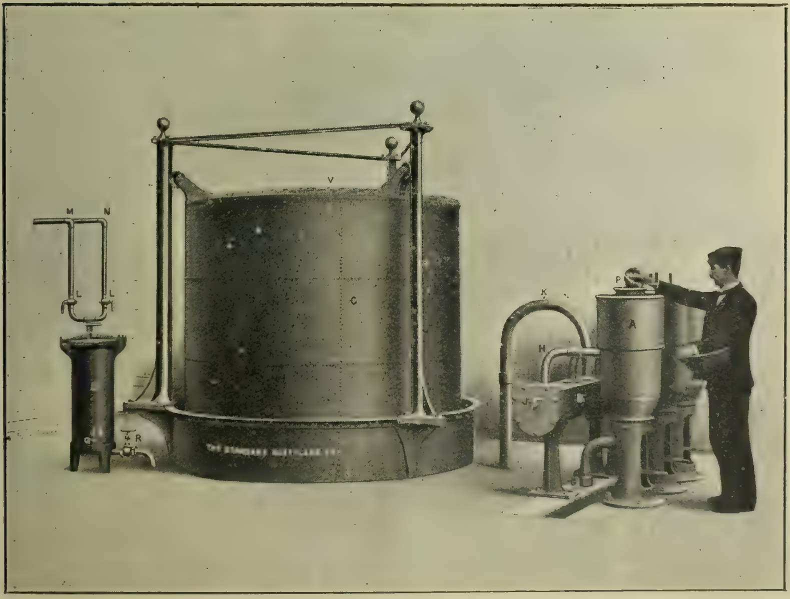


FIG. 11.—Hand-controlled Acetylene Plant (The Standard Acetylene Co.).

this habit of early burners was the fact that metal was used; nowadays, refractory materials such as steartite were used. One notable improvement had been the introduction of a burner in which two flames at an angle played upon one another; the flame-temperature and efficiency was increased thereby, and it was also claimed that the tendency to choke was reduced. The modern acetylene burner probably yielded about 30–35 candle-power per cubic foot of gas per hour.

Acetylene had also been applied to incandescent mantles; unfortunately, this very high temperature caused mantles to deteriorate somewhat rapidly. It had been claimed that the Hella Bush light was specially suited for the acetylene flame, as the refractory needles of which it was composed were able to stand the temperature better.

Reference was next made to dissolved acetylene. The convenience of dissolved acetylene was early realized, but there were many initial difficulties to overcome, and not a few serious explosions.

Recently, however, a great development had been achieved through the use of the comparatively cheap liquid acetone, which possessed the remarkable property of dissolving about 240 times its own volume of acetylene at a pressure of 10 atmospheres, and a temperature of 15 degrees; such a vessel of acetone saturated with acetylene gas at this pressure would therefore liberate 215 times its own volume when the pressure was reduced to ordinary atmospheric value.

Like the other systems described, acetylene lighting was essentially a self-contained portable system, and came into use mainly where electricity and gas were not available. It might indeed be said to fill positions very similar to those for which petrol-air gas was intended, so that the competition between these two systems of illumination was naturally somewhat keen.

There were, however, many cases in which dissolved acetylene was particularly serviceable. For instance, when it was necessary to install a generator on a railway train, the bulk taken up by the apparatus would be a considerable disadvantage. More recently, however, dissolved acetylene seems to have proved very convenient on long distance trains.

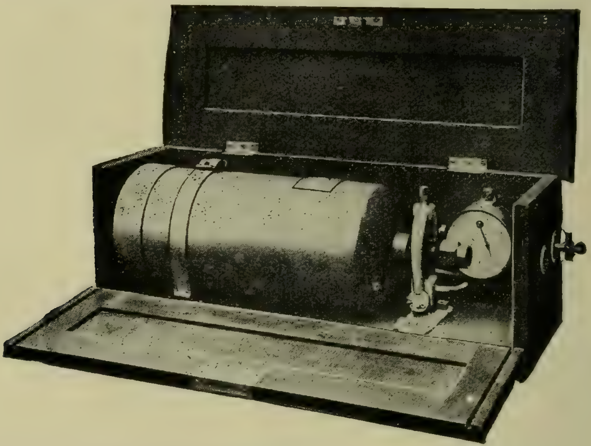


FIG. 12.—Dissolved Acetylene Outfit, suitable for Motor-Cars, &c.

Another field in which liquid acetylene might be expected to play a useful part was for omnibuses and motorcar lighting, and had even been utilized for emergency lighting on festive occasions in churches.

Naturally acetylene obtained in this way must always be somewhat more expensive than when obtained from a generator, but this was compensated for by the greater convenience.

However, there was one field in which dissolved acetylene had found a very extensive application indeed, namely, for the lighting of buoys, beacons, &c., in inaccessible places (see *Illuminating Engineer*, vol. i. 1908, p. 905). Canada had found such installations of very great value for buoys on her great rivers, and Sweden, whose maritime system of illumination was exceedingly expensive, had employed dissolved acetylene very extensively. By the kindness of the Acetylene Illuminating Co., several ingenious automatic devices for use with buoys of this character were shown in operation.

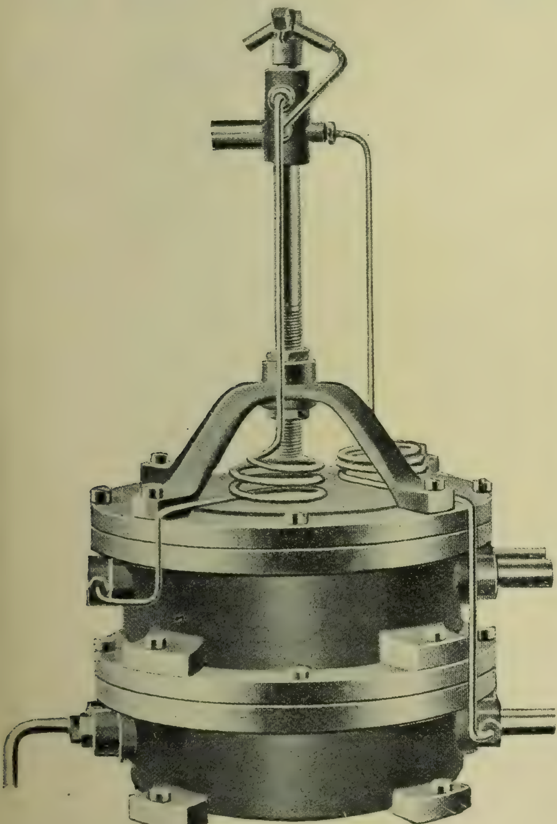


FIG. 13.—Dalen Acetylene Flashlight Apparatus.

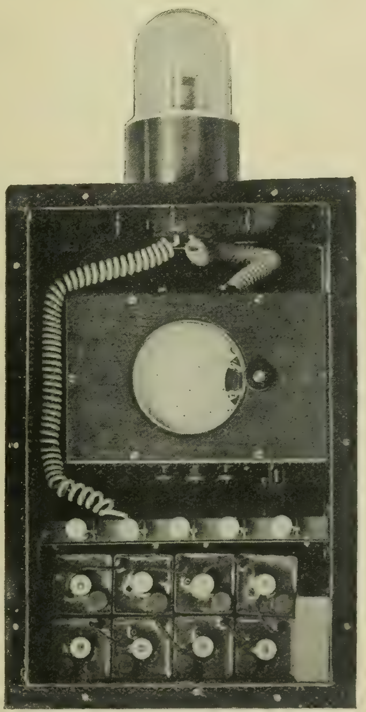


FIG. 13A.—Ruhmer Selenium Cell applied to the Automatic Lighting and Extinguishing of Buoys, &c.

The working of the Dalen "solar valve" apparatus was based upon the action of two sets of rods, some of which were black and absorbed solar radiation, while the others reflected it. This gave rise to a difference in temperature, and consequently to an unequal expansion during the day which causes a lever to turn and cut off the supply of acetylene. During the night, however, when the sun's rays were absent the cock was open, and the apparatus was thus completely automatic. Similar devices using the property of the selenium cell, the resistance of which was enormously diminished by the action of light, had also been employed in Germany.

A second ingenious saving device was the Dalen flashlight apparatus, which worked absolutely automatically by the pressure of the gas. This enabled a flashing system to replace continuous lighting and thus a considerable saving in the amount of gas consumed could be affected according to the durations of the flash and the corresponding period of darkness. For instance, a flash of a duration of

one-third of a second every third second would lead to a saving of 90 per cent. Yet the efficiency of the apparatus might not be impaired thereby; indeed the intermittent light might be more effective in attracting attention. The period of the flash could be very simply adjusted by merely turning a screw.

Comparative Costs of Illuminants.

Mr. Gaster then remarked that having described so many systems of illumination, he might be expected to give some account of their relative costs. He therefore threw upon the screen some tables compiled by different authorities, explaining how different assumptions were made in each case, but more uniform results were obtained when they were reduced to the same conditions. Therefore he considered that though such tables might be useful to manufacturers as a means of comparing the efficiency of different sources, they were apt to be very misleading if a consumer tried to apply them to his own practical needs. It was, for instance, absurd to compare a 1,000 candle-power unit with a small candle-power glow-lamp; again, the actual method of measuring the light on which such comparisons were based often differed in the case of different types of lamps. In short, every case must be considered on its merits.

The following, however, represented the mean of a series of results recently published by four different authorities:

Cost of Gas, Oil, or Electric energy only per 1,000 c.p. Hours (Electricity 4*d.* per unit, Gas, 2*s.* 6*d* per 1,000 cub. ft.). (Carbide 3*d.* a lb., Perrol, 1*s.* 2*d.* a gallon, Paraffin, 7*d.* a gallon).

	s.	*d.*
Electric Flame Arc		1
High Pressure Gas		1¼
Incandescent High Pressure Oil		1¼
Petrol Air Gas		2
Electric Mercury Vapour Lamps		2
Self-Intensifying Gas Lamps		2¼
Incandescent Mantle (Low pressure)		3
Alcohol Incandescent Lamps		3
Electric Open White Arc Lamps		3
Enclosed Arc Lamps		4
Helion Electric Glow Lamps		4
Moore Tube (Electric)		4½
Tungsten Electric Glow Lamp		5
Osmium Electric Glow Lamp		6
Alternating Arc Lamp		6¼
Argand Gas Burner		7
Tantalum Electric Glow Lamp		7½
Miniature Arc Lamp		7½
Nernst Electric Glow Lamp		7½
Metallised Electric Glow Lamp		8½
Oil Lamp		9
Flat Flame Gas Burner		11
Carbon Filament Electric Glow Lamp	1	2½

Theory of Light-Production.

Finally, the lecturer gave a brief description of some of the underlying scientific theories of light production. He explained the nature of the radiation from the incandescent solids and incandescent gases, pointing out that an incandescent source which approached the theoretical black body

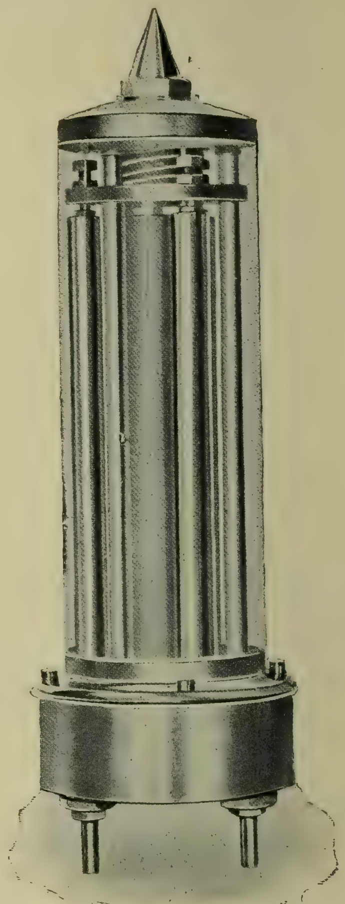


Fig. 14.—Dalen Sun-Valve for Automatically Cutting off Gas-supply in Daylight.

must always be an inefficient source of light. Some diagrams showing the distribution of radiation in the spectrum of a black body at different temperatures were then exhibited, it being demonstrated how the percentage of visible light rose as the temperature was increased until at the enormous temperature of 7,000 degrees it might be as high as 50 per cent.

Of course, we could not obtain this temperature at present, and therefore, the efficiency of flame incandescent sources of light was always very low. Langley, however, had pointed out that the energy in the spectrum of the light from a firefly seemed to be entirely concentrated within the visible range.

Attempts had been made to utilize the free, natural vibrations of a luminescent gas. Unfortunately, though we improved the efficiency by so doing we usually obtained discontinuous spectra and colour distortion. A table obtained by Mr. Stickney (*Transactions* of the Illuminating Engineering Society, May, 1907) was then thrown upon the screen illustrating how natural colours were distorted by various modern illuminants.

The change in appearance of coloured objects under artificial light was, as Mr. Stickney's figures suggest, a matter of considerable importance to architects and others interested in the provision of wall papers and furniture so designed as to produce a given decorative effect.

For instance, red rays falling upon violet causes it to appear purple, yellow rays falling on blue gave rise to a slaty-grey colour, &c.

In such cases it was necessary to bear in mind that a room which had certain characteristics in daylight, might appear very different in the evening by artificial illumination. This, therefore, was a matter on which reliable data might be very useful, and there was still room for systematic study.

THIRD LECTURE, MARCH 1ST, 1909.

THANKS are due to the following firms who have kindly exhibited at the third Cantor Lecture :—

The Gas Economizing and Improved Light Syndicate, Ltd. (Blanchard System).—One 500 candle-power self-contained paraffin incandescent lamp fitted with inverted burner ; one portable table lamp working on same system.

The United Kingdom Lighting Trust, Ltd.—Examples of latest type of Kitson Empire incandescent petroleum self-contained lamp of 1,000 candle-power, in actual operation.

Messrs. "Petrolite," Ltd.—Two examples of "Petrolite" petroleum incandescent lamps.

Messrs. Falk, Stadelmann & Co., Ltd.—Specimen of "Lucisca" portable petroleum incandescent lamp.

The Universal Gas Methane and "Buisson Hella" Co., Ltd.—Portable incandescent petroleum lamp fitted with "Hella Bushlight" mantle and burner.

The Machine Gas Syndicate (Cox's Air-Gas System). — Complete running plant in actual operation (estimated capacity 280 cubic feet per hour, 28 lights each consuming 10 cubic feet and yielding 125 candle-power), supplying air-gas to various burners, the gas being passed through piping immersed in a freezing mixture, with the object of demonstrating that there is no condensation.

The National Air Gas Co., Ltd (Glascoe's Patent).—Exhibition of complete running plant in actual operation (20 burners of 50 candle-power or 40 of 25 candle-power 100 cubic feet per hour estimated capacity) feeding various types of inverted and other incandescent mantles.

Messrs. Strode & Co. (Aerogen System).—Exhibition of complete running Aerogen plant in actual operation (estimated capacity, 35 burners, each consuming 2 cubic feet of gas, and yielding 25 candle-power), supplying petrol air gas to various inverted and other burners.

The Acetylene Illuminating Co., Ltd.—Complete dissolved acetylene outfit suitable for motor cars, lanterns, and other purposes ; acetylene flashlight apparatus (Dalen Patent) ; sun valve for automatically cutting off gas supply in daylight (Dalen Patent) ; oxygen acetylene jet for lantern purposes ; incandescent acetylene burners for motor headlights, &c.

The Standard Acetylene Co.—Complete generating plant for 30 burners of 20 candle-power, capacity of bell 10 cubic feet of gas ; charge of carbide of 12 lb., water to carbide feed, supplying acetylene to series of elegant types of burners, in actual operation.

A specimen of non-combustible carborundum wick for use with spirit lamp, &c., the invention of Dr. B. Monasch, of Augsburg, was also on exhibition.

Some Notes on the Historical Development of Street-Lighting in London in the Seventeenth and Eighteenth Centuries.

Continued from p. 88.

By an Engineering Correspondent.

Some still removed place will fit,
Where glowing embers through the room
Teach light to counterfeit a gloom;
Far from all resort of mirth,
Save the cricket on the hearth;
Or the bellman's drowsy charm,
To bless the doors from nightly harm.
Milton's 'Il Penseroso.'

We can hardly imagine the condition of things in the time when, by Statute of Edward I., it was ordered "that none be so hardy as to be found going or wandering about the streets of the City after curfew tolled at St. Martin's-le-Grand, with sword or buckler, or other arms for doing mischief, or whereof evil suspicion might arrive, nor in any other manner, unless he be a great man, or other lawful person of good repute, or their certain messengers, having their warrants to go from one to another, with lanthorn in hand"; or when still in 1704, by Act of the Common Council, it was provided "that for the small precinct of Blackfriars 6 men were ordered to patrol the street all night, and that for Monkwell Street alone two men were to walk up and down all night."

At this date there were no lights at all in extensive districts in London, and in the others the few lanterns glimmered feebly before only one house in ten, and during but a small part of one night in three. We need not wonder that crimes were of such ordinary occurrence, that the Lord Mayor and Aldermen in 1744 presented an address to the king, representing "that divers confederacies of great numbers of evil-disposed persons, armed with bludgeons, pistols, cutlasses, and other dangerous weapons, infest not only the private lanes and passages, but likewise the public streets and places of public concourse, and commit most daring outrages upon the persons of your Majesty's good subjects, whose affairs oblige them to pass through the streets, by terrifying, robbing, and wounding them; and these facts are frequently perpetrated at such times as were heretofore deemed hours of security."

In the time of Charles II. Dryden was waylaid by a gang of swaggering bullies and hired ruffians; and in 1712 we hear of the Mohocks, another gang of young fellows from the upper ten, who used to amuse themselves with "games" called "tipping the lion," *i.e.*, to squeeze the nose of their victim flat upon his face, and to bore out his eyes with their fingers (*vide* Lecky's 'History of England in the Eighteenth Century'; quotation from Swift's 'Journal to Stella'; Gay's 'Trivia'; *The Spectator*, 327, 335, 347). Other clubs were the Muns and Tityre, Tus, the Hectors, the Scourers, the Nickers, the Hawcubites. The Sweaters—and other bands of fashionable noblemen — used to form a circle round their prisoner and prick him with their swords till he sank exhausted to the ground. Another club was that of the Dancing Masters, so called from their skill in making men caper by thrusting swords into their legs.

Even in 1780, in a letter of June 7th, Richard Burke wrote: "This is the fourth day that the metropolis of England is possessed by an enraged, furious, and numerous enemy. Their outrages are beyond description, and meet with no resistance." Most of the crimes—I dare say 75 per cent of them—were committed in the night, and the ill-lit and ill-guarded streets constituted one of the chief causes. The Government was weak and the police power-

less. The magistrates dared not call out the Guards for fear of being hung, and the Guards used not to come for fear of being given up to the blind rage of popular juries.

"Officers of justice," wrote Sir John Fielding ('Causes of the Increase of Robbers'), "have owned to me that they have passed by such with warrants in their pockets against them, without daring to apprehend them, and indeed they could not be blamed for not exposing themselves to sure destruction, for it is a melancholy truth that at this very day a rogue no sooner gives the alarm within certain purlieus than twenty or thirty armed villains are found ready to come to his assistance."

Although in compliance with ancient customs (*vide* my first article), it was enacted by the Statute 2 William, Mar. i. 8 (superseded 1736 by 9 Geo. II. c. 20), "that housekeepers in the City of London and within the bills of mortality, whose houses adjoin to the streets, should hang out lamps from the time it grew dark till 12 o'clock at night from Michaelmas to Lady Day, or pay for lamps, under the penalty of 2*s*. for every default," &c., yet dark streets were infested by gangs of thieves and robbers, till proper lighting of them put an end to their pillage for ever.

The progress of industry had rendered it necessary that "others besides great men and their accredited messengers should go about a night."

Moreover, the population was increasing. There was the greatest difficulty in maintaining any effective industrial and social order in such a rapidly increasing centre of population, and the machinery of municipal institutions proved insufficient to grapple with the situation. From about the middle of the eighteenth century onwards, an almost continuous stream of special Acts of Parliament conferred new powers of regulation, collective provisions, and taxation which enabled the town to cope with the difficulty with greater success. These new powers were conferred upon the Corporation itself,* and exercised by its governing council or by bodies of commissioners appointed and controlled by it, or to new bodies, established for the special purposes desired, "ad hoc" authorities, *i.e.*, new statutory authorities created for the purpose, among other things, of considering the lighting of the streets of London.

We must bear in mind the fact that the administrators of the City had originally in mind only the suppression of nuisances. To this fundamental function were added such services as the lighting of the streets. We must also recollect that lighting as well as paving and cleansing and all other local needs were regarded as *personal* responsibilities, and the function of the municipal corporations in these directions had been confined, for the most part, to *enforcing* obligations on householders.

We have to go back to the Act of 1585 (Burleigh's Constitution) to the Court of Burgesses (consisting of twelve unpaid Westminster tradesmen and twelve others as Assistant Burgesses), who made "Order and Ordinances," and had to hear, examine, and punish according to the laws of the realm. Every Westminster shopkeeper, for instance, was intended to keep a constant supervision over his neighbours and report on any neglect of the householders' obligation to light the street opposite his frontage.

At the beginning of the eighteenth century Ward organizations enforced upon the householders onerous obligations of personal services. It was the Ward inquest, on its periodical round, which threatened the householder with the law for omitting to hang out a lantern with a lighted candle on the nights when there was no moon, as directed by Act of Common Council of 1716 (*vide Illuminating Engineer*, February, 1909, p. 87). But as soon as these personal services were undertaken by contractors, and carried out by hirelings, at the expense of funds collected from the Ward in rates, a more responsible executive organ for the assessment and collection of the rates and the control of the administration was formed, namely, the Common Council of the Ward. Nevertheless

* For most of the following records I am indebted to the excellent work of B. and S. Webb, 'English Local Government.'

we must not forget the fact that the lighting of the City streets was far superior to what was done elsewhere, and that it was done by the constant pressure of the inquest juries. The Inquest of Vintry Ward even prosecuted the Lord Mayor, Aldermen, and Commonalty — the City Corporation itself [*sic*]—for neglecting to light a certain "common house of easement," which they had to maintain (*vide* MS. Records, Vintry Ward, 1696).

The Inquest Jury was superseded by the Common Council of Ward, and the lighting of the narrow streets passed as an *organized* service into the hands of the Common Council of the Ward. By Statute of 1736, Parliament empowered the Aldermen, Deputy, and Common Councilmen of each Ward to contract for the lighting of the Ward, and to levy a rate for the purpose (9 George II. c. 20, 1736; 'Journals of the Court of Common Council,' Oct. 22nd, 1735, July, 8th, 1736, and Sept. 17th, 1736; amended by 17 George II. c. 29, 1744; Journals of the Court of Common Council, Oct. 16th, 1744, vol. lviii. p. 338).

The business of lighting came at last into the hands of the Commissioners of Sewers, a body established by Local Acts of 1667, 1672, and 1771, for many years only a committee for elaborating and supervising the obligations of the householders (*vide* Fitzherbert, 'Natura Brevium' 113). The commissioners of Sewers were subsequently invested (*vide* 11 Geo. III. c. 29, explained and amended by 33 George III. c. 75, and 4 George IV. c. cxiv.) "with the whole power of lighting the several streets, lanes, squares, yards, courts, alleys, passages, and places within the said City and liberties. For the better lighting of the said streets, &c., the Commissioners are authorized to cause such and so many lamps to be set up in such places within the said City and liberties, and to be placed in such manner and at such distances as they judge necessary; and to order and direct at what time the lamps shall be lighted, and how long they shall continue lighted, and from time to time to give such orders and directions as they think needful" (*vide* C. Welch, 'Modern History of the City of London').

As mere curiosities I may add to these notes two further records dating from the seventeenth and eighteenth centuries.

The first relates to 1691, when the Lord Mayor was by the Court of Aldermen "desired to issue forth his precepts to the Aldermen of the several Wards....to require every inhabitant within their respective Wards to hang out their lights according to ancient customs, and to take especial care that the Ward and Parish lights be duly hung out" ('Repertories,' vol. xcv. Oct. 6th, 1691).

The second dates from 1737–1738, when the Court of Burgesses contemplated getting powers to put up lamps to light the streets, the Vestries protesting that this service "should be parochial and not general" (MS. Vestry Minutes, St. Martin's-in-the-Fields).

Dr. B. S.

Electrical Trades Benevolent Institution.

We have received from the Secretary a notice of the first Festival Dinner in connexion with the Electrical Trades Benevolent Institution, to take place on March 30th, at the Hotel Metropole. Sir Wm. H. Preece, K.C.B., F.R.S., has kindly consented to preside.

We are very glad to comply with the request of the Secretary to draw attention to the objects of The Institution, and we understand that several grants of temporary aid have been made by the Committee quite recently. Particulars can be obtained from the Secretary of the Electrical Trades Benevolent Institution, Ridley Place, Holland Street, Blackfriars, S.E.

REVIEWS, ABSTRACTS, AND REPRODUCTIONS.

The Bearing of Modern Illumination upon Physiological Optics.

By Sydney W. Ashe.

(Abstracted from *The Electrical World*, New York, February 25th.)

Helmholtz states that, when studying the effects of illumination upon the eye, one is dealing with a physiological and not a physical problem. This fact soon becomes apparent to any one making light measurements. For instance, the actual size of the pupil plays a very important part in our judgment of light intensities; the writer describes some experiments on this point.

In connexion with the above-mentioned measurements of the pupil, a large number of measurements were made upon the variation of visual acuity for lights of different intensities and of different intrinsic brightness. Other phases of the investigation have been to determine the effect upon visual acuity of foreign lights placed in the field of vision—the effect of size and shape of different letters upon one's ability to read, the effects of accommodation and of fatigue. This work is now being carried on at Columbia University by the writer in collaboration with Mr. Rice, under the co-operation of the Departments of Psychology and of Physics.

Up to the present time a large amount of work has been devoted to the development of new apparatus for making accurate measurement, the standardization of instruments, and the elimination, so far as possible, of all physical errors. All of the illuminants are supplied with energy from a storage battery, and the e.m.f. being maintained constant. All values of the candle-power of the various coloured illuminants have been carefully determined by means of the flicker photometer develcped by the late Prof. Rood.

The elimination of physiological errors has been a more difficult problem than the elimination of the physical errors; the former are eliminated only by taking a large number of readings upon various subjects and at various times. For instance, when measuring the visual acuity by means of a Snellin's chart the writer would find, after entering a dark room and beginning observations immediately, a tendency to read high; the effect mentioned being due probably to the accommodation or adaptation to the eye in the darkened room to the light intensity under test. When the process of taking observations had continued for about an hour, successive readings began to vary widely in accuracy, due to general fatigue of the eye. The fatigue is especially trying when making observations with red light.

It is found, after taking all precautions, that variations still exist due to a change in the physical condition of the individual, This result seems natural when it is remembered that the eyes reflect the general condition of fatigue of the body, or what is termed a feeling of sleepiness comes over one when he is bodily tired, although his eyes may not have been used at all for reading.

To eliminate so far as possible errors due to changes in the physical condition of the individual, it was necessary to take observation in the morning when the eye and body were thoroughly rested, and to take the observations about the same time each day. It was also found desirable to reverse the order of taking the observation; for instance, to use the lights in the order red, green, and blue for several mornings; then blue, green, and red, and red, green, and blue, to determine what effect the fatigue of a particular colour might have upon the visual acuity when reading with another colour of illumination. The results obtained thus far are interesting, as showing a wide variation from somewhat similar tests made by Messrs. Andre Broca and F. Laporte, as reported by them in the *Bulletin de la Société Internationale des Electriciens*, June, 1908. Their conclusions, which have been much quoted, are given literally as follows:—

"1. The question may be asked whether industrial lights of different colour, compared by means of a photometer with

equal intensity would be equivalent in giving to the eye acuity of vision, ease and quickness of reading.

"2. We have just seen that the incandescent carbon lamp and the mercury arc giving the same intensity measured on the most simple possible photometer give also the same practical visual acuity.

"3. The rapidity of observation is independent of the nature of the light and also the intensity of the light, if the distance of the observer from the test is in each case the same fraction of the limited distance for reading.

"4. Our measurements show the fact which has been much discussed that the photometric measures executed with industrial and utilizable intensities determined very fully the practical value of the lights.

"5. Knowing the physiological properties of the eye and the mean limits of accommodation we recommend as a suitable intensity for work a value of from 20 lux to 40 lux.

"6. The study of the pupilary contraction shows that it is necessary to remove the luminous source from the field of peripheral vision. The contraction seems to depend more on the brightness of the luminous source than its distance. One ought, therefore, to recommend the use of lamps with reflectors and with globes of such dimensions that the intrinsic brightness will be relatively feeble. Indirect lighting from diffused light sources hidden from view fulfils the requirement completely.

"7. The contraction of the pupil caused by peripheral vision of the lamps is the more harmful to visual acuity as the illumination of the text is the more feeble, and this may cause in this case considerable fatigue. On the contrary, it becomes less important when the intensity is from 20 lux to 40 lux. In certain cases of powerful intensity the presence of a brilliant source in the peripheral field is able to increase the visual acuity, but at the cost of inadvisable fatigue.

"8. The study of the residual images on the retina leads to the recommendations already given of removing luminous sources of light as far as possible from the field of vision.

"9. The different luminous sources arrange themselves for pupilary contraction and persistence of residual images according to the order of their respective intrinsic brightness. However, the mercury arc, which had the most feeble intrinsic brightness among the lamps which we have studied, makes an important contraction of the pupil. It does not show, therefore, all of the advantages which one would have expected. When one is able to avoid the direct view of the luminous source it is absolutely indifferent from the point of view of hygiene of the eye which of the industrial lamps is chosen."

Referring to paragraph 2 of these conclusions the writer presents the curves of Fig. 1, which show the variation in the visual acuity for the writer's eyes for lights of different colours—red, blue, and green. While the number of observations which have been taken are not sufficient as yet to derive the equations of the curves and establish a law for average conditions, the fact has still been apparent for all of the observations that there is a marked difference in the visual acuity or one's ability to read, depending upon the colour used. All of the values of light intensity have been reduced to meter-candles by dividing the candle-

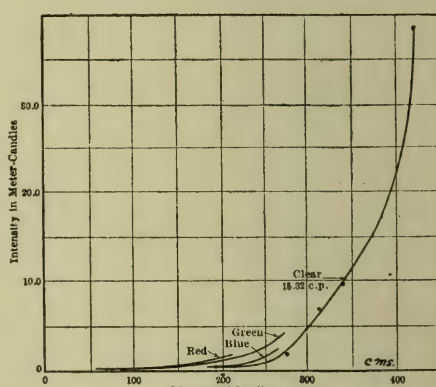


FIG. 1.—Variation of Visual Acuity with Colour.

power by the square of the distance of the light from the chart in meters. In Fig. 1 the reading distance is expressed in centimeters.

The manner of making the observations was as follows: Referring to Fig. 2, *A* represents a Snellin's chart, the capital letter *R* on one of the lower lines being chosen for observation. The height of this letter divided by the distance from the chart at which it may be read is termed the visual acuity. Referring to Fig. 1, instead of dividing the reading distance by the height of the letter, the curve has been plotted with distance directly as abscissae. The values, however, can be readily converted to visual acuity by using the value 0·4 cm. the height of the letter *R*. At 300 cm. the visual acuity is $0{\cdot}4/300 = 0{\cdot}01332$. This letter was used in the observations because it was more difficult to discern than the other

letters in the same row, such as *N*, *A*, *D*, &c. *B* is a lamp mounted in a box, one side of which is open so as to illuminate the chart *A*. The lamp is movable so that it may be set at a given distance along the beam *D*, which is graduated. The lamp voltage is maintained at a constant value by means of the voltmeter, adjustable resistance, and storage battery service *F*. A steel scale *E* hangs loosely, fastened at one end, at the chart, and can be brought to the eye of the observer giving the reading distance. Fig. 1 shows a series of observations taken in this manner. While the relative position of these curves seems to shift slightly from day to day—depending, as previously stated, upon the physical condition of the individual—nevertheless there is always a decided difference in the visual acuity for different coloured illuminants of

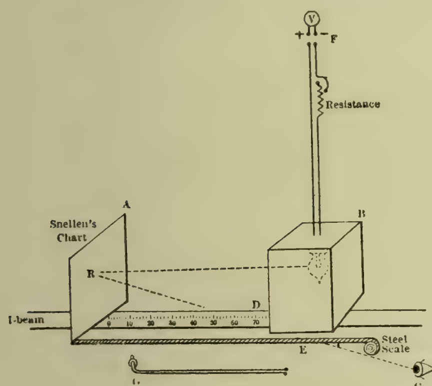


FIG. 2.—General Arrangement of Apparatus.

the same meter-candle intensity. The reason why Messrs. Broca and Laporte could not appreciate this difference in the visual acuity may possibly be explained in the manner in which their observations were made.

If the authors had used a flicker photometer to determine the relative intensities of the lights of different colour, no doubt this difference, due to a difference in the colour effect, would have been appreciated.

The following method has been used by the writer and his associates to study the contraction of the pupil :—

The arrangement for illuminating the lamp and adjusting it was the one used in the previous experiments on visual acuity. For the Snellin's chart was substituted a support with an opening in it, as shown in Fig. 3 ; across this opening are mounted two cross-hairs, one of which is fixed and the other movable, being connected to a stirrup, as shown in Fig. 3 at *b*. The distance between the cross-hairs is magnified by means of a simple lever, as shown in *b*. The size of the pupil can thus be measured very accurately. The observer looks

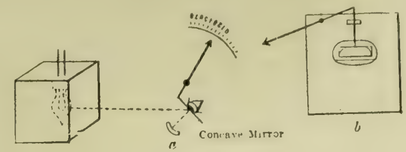


FIG. 3.

Apparatus for Measuring Diameter of Pupil.

through the opening into a small concave mirror with a radius of curvature of 2 in. adjusts the cross-hairs and takes the reading, the eye being so placed that it almost coincides with the cross-hairs. While it is true that the size of the pupil as thus determined is slightly refracted, due to the cornea, the percentage of error is about the same with all observations, and is therefore satisfactory for comparative work.

Fig. 4 shows a series of observations taken upon the pupil with two sources of light, a green lamp and an ordinary 16 candle-power lamp placed at such distances that their intensities on the eye were equal. The lamps were then placed at different angles in the field of vision, namely 0 deg. to 30 deg., 50 deg. to 75 deg. The readings were as follows :

Green lamp:	
30 deg.	4·03 m.m.s·
50 deg.	4·25 m.m.s·
75 deg.	4·75 m.m.s.
Carbon lamp:	
0 deg.	3·90 m.m.s·
15 deg.	4·03 m.m.s·
30 deg.	4·51 m.m.s.
50 deg.	4·85 m.m.s.
75 deg.	5·32 m.m.s.

These results were the averages of a number of readings. It will be noticed

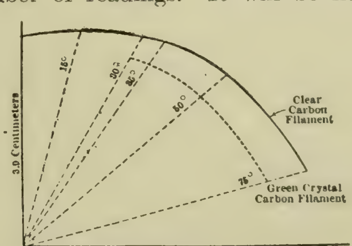


FIG. 4.

Curve Showing Size of Pupil when Exposed to Illuminant at Various Angles in Visual Field.

from these readings that, as a lamp is brought into the field of vision, the angle becoming shorter and shorter, the pupil of the eye contracts more and more.

Although no image of the lamp is formed on the fovea of the eye except when the light is at zero, it will be noticed that the pupil contracts gradually as the lamp is brought into the field of vision, and that the contraction is greater for the green than for the approximately white light of the carbon filament, the light containing nearly all rays of the upper part of the spectrum. Upon the fovea is focused, by the accommodation of the lens, the image of the letter which one is attempting to read, but the sharpness of this image is probably affected by the excess of light flux on the retina, by the foreign lamp in the field of vision. The writer has found that the presence of a foreign lamp in the field of vision decreases one's ability to read by approximately 30 per cent for an ordinary 16 candle-power carbon incandescent lamp.

The curve sheet of Fig. 4 is interesting in view of the modern theory of colour perception based upon the number and location of rods and cones over the retina. If there is practically no colour perception outside of the fovea one would imagine that the size of the pupil would be the same at a given angle irrespective of the colour, but experiment seems to point to the opposite effect, as indicated by the curves.

Eye-Sight Troubles of Wireless Telegraphy Operators.

(Note sur les lésions déterminés par l'emploi de la Télégraphie sans fil à bord des bâtiments, par Dr. P. Bellile, médecin de 1re classe de la Marine, *Archives de Médecine Navale*, March, 1909, p. 207.)

Public attention has recently been directed to the injurious effects of Röntgen rays upon early operators in this field, and yet more recently there has been much discussion as to the action of ultra-violet energy upon the eyes.

On this account a communication in a recent number of *Archives de Médecine Navale* (March, 1909), published under the direction of the Ministre de la Marine in France is of exceptional interest.

This note by Dr. P. Bellile refers to the experiences of certain telegraph operators on the battleship Descartes, which, during the recent Tangiers Expedition, was called upon to undertake an exceptional amount of wireless correspondence. As a result many operators had to remain at their work for eight hours at a stretch.

The operators frequently complained of trouble in connexion with their eyes and disturbances of vision, and the author believes that this was due to the effect of the rays emitted by the spark employed for transmitting in the case of wireless instruments, being analogous to the well-known effect of incautious exposure to the naked arc-light.

In several cases defective visual acuity was experienced, and was ascribed to actual malformation of the eye-lens arising from the action of these rays ; so clearly did this injury appear to be due to the occupation of the sufferers, that a certificate to this effect was actually granted. Other symptoms were the appearance of a form of eczema on the hands and wrists of operators, and palpitation of the heart, and other nervous ailments. In addition, one man suffered such a marked deterioration in eye-sight as to exclude him from readmission to the service, and yet no actual physical injury could be traced in the eye to account for this defective visual acuity.

The author suggests that the short, thick spark used in wireless apparatus, being particularly rich in ultra-violet radiation, is directly responsbile for eye-trouble ; continuous exposure to such sources, he thinks, may ultimately lead to deep-seated defects such as atrophy of the optic nerve. It is therefore proposed to provide special forms of spectacles devised to absorb the objectionable radiation for the use of operators.

But he also raises the question whether the actual wireless electromagnetic waves may not exert some injurious physiological action on those constantly living in their neighbourhood ? The existence of such waves, easily conducted as they are by the metal framework of battleships, is readily demonstrated to those on board by the fact that sparks can often be drawn from the finger, while the wireless apparatus is working. There are certain indications of nervous ailments on the part of sailors that have given some concern of late years, and may prove to be due to this cause.

In conclusion, the author remarks how unfortunate it is that each development in physical science seems to be attended by the ultimate recognition of some at first unsuspected source of physiological injury, to be guarded against. This has been found to be true of the Röntgen and other rays, and experience seems to be now demonstrating the existance of a corresponding quality on the part of the electro-magnetic waves used in wireless telegraphy in addition.

CORRESPONDENCE.

The Internal Lighting of Churches.

February 16th, 1909.

DEAR SIR,—It is with pleasure I note that your esteemed periodical is creating new interest on the subject of lighting churches by artificial means, for to my mind no other class of work in the field of illuminating engineering requires more careful handling to obtain desirable results. In this work an illuminating engineer not only has to exercise his skill to obtain technical, practical, and æsthetic results, but he also has to use considerable ingenuity in order to apply modern illuminants in churches where the architecture is of ancient origin and historic interest. This condition of affairs should certainly prompt the architect to consult a competent illuminating engineer when his plans for an edifice of this character are in the rough, so that suggestions may be offered with a view to meeting, at the same time, the æsthetic, religious, and utilitarian aspects.

I have read Mr. Leonard Stokes's letter, printed in the February issue of your periodical, in which he states that the illuminating engineer should leave the matter of designing artificial lighting systems for churches wholly to the architect, inasmuch as he feels that the illuminating engineer does not possess the appreciation of æsthetic and religious feeling necessary to cope with the work. I would like to write at some length and in detail on this point, but refrain from doing so, because this should be left to your Engineering Correspondent, whose article on this general subject was responsible for Mr. Stokes's letter. I cannot help repeating, however (I say repeat, because it has been a policy which I have many, many times given voice to), that the competent illuminating engineer is, or should be, able to appreciate architecture about as fully as the architect, inasmuch as to design lighting systems intelligently one must appreciate the value of æsthetics and have a goodly portion of that which is ordinarily termed "good taste."

For the benefit of architects and the protection of competent illuminating engineers it might be well to state here that simply because a man is competent to construct and instal an arc lamp, to give certain results, it does not necessarily mean that he is an illuminating engineer, and therefore qualified to design lighting systems for churches. But if he understands the manipulation of arc lamps in connexion with the performances and characteristics of other artificial illuminants, and possesses a knowledge of what they will do under various conditions, with different equipments, and has a high appreciation for the beautiful, the harmonious, he is perhaps qualified to carry out this class of work.

It might be interesting to note here that some time ago the writer was called in as consulting and designing engineer to design a lighting system for one of the largest cathedrals in the United States. The bishop in charge of the building arrangements wanted the arches, and other similar lines in the church, outlined with incandescent lamps. The architect, a man of recognized ability, desired to provide illumination almost wholly by indirect means, by placing the artificial illuminants at the base of the arches, and throwing their rays upon the ceiling, some forty or fifty feet distant.

It is hardly necessary for me to state that in carrying out either of the

proposed schemes the effect of the architecture would have been spoilt. After much persuasion I was able to convince the bishop and architect that the proposed schemes were not desirable, and therefore should not be put into practice. From this illustration it will be seen that it is possible for the architect as well as the engineer to err, neither being infallible. The illuminating engineer, especially the person who appreciates the fact that his profession is young, and is therefore more or less dependent upon assistance from other sources, does not know it all, neither does the architect. But by mutual co-operation a better understanding of the subjects common to both could unquestionably be brought about, and excellent results obtained. Therefore, instead of one medium endeavouring to lessen the value of the other by expending a lot of valuable energy, I think it would be as well to use such energy in bringing about harmonious, utilitarian, æsthetic, hygienic, and practical results.

While the question of interior lighting of churches by artificial means is up, it might be interesting to mention a scheme I designed some time ago, for use in connexion with stained glass windows, in a church. The church in question contained many valuable and handsome stained glass windows, the merits of which were appreciated by the comparative few, because it was only by daylight that they were properly exhibited. Inasmuch as the interior lighting of the church was of a soft, effective, religious tone, it was possible to design a system of exterior lighting which displayed the windows in a very effective manner. Care, however, was taken not to make the lighting too brilliant, as this might have rendered them a source of attraction rather than the religious service; also to provide uniform distribution of illumination, so that each portion of the window received full consideration. I think that, where churches are dimly lighted and possess these exquisite works of art, the idea of properly illuminating them should be given consideration. Particular care should be taken not to spoil the exterior appearance of the church, and the scheme should be carried out efficiently and economically.

In attempting to illuminate stained glass windows, skylights, &c., the illuminants are ofttimes placed and equipped so that a spotty effect is noticeable, which, of course, is very undesirable. In this particular class of work I have often found it necessary to introduce a diffusing plate, because the stained glass was not of sufficient density to permit absolute diffusion.

Yours very truly,

A. J. Marshall,

Chief Engineer of the Bureau of Illuminating Engineering, New York.

Sir,—The letters of your various correspondents on this subject have proved of considerable interest; I venture, however, to bring before their notice a few more striking references of authorities to the illumination of various famous religious edifices, which illustrate the views brought forward in my previous letter.

Spon, after visiting the famous Temple of Minerva at Athens, the Parthenon which the Mahometans had converted into a mosque, described it thus :—

"When I entered the mosque I was not surprised, as others have been, at its darkness. The little light it had came from the back part, which the Christians opened when they made use of it as a choir. In the ages of Paganism, this temple had no light but that which entered at the door, and which gradually faded away when you entered the pronaos, which was only faintly lighted through the first portal. I should rather have wondered at seeing windows here, as they are very seldom found in the ancient temples. The Temple of Theseus at Athens also has no light, but what is received from two or three openings, which the Greeks have made, without any symmetry, in the roof, because they wanted to use this temple as a church; and it is easy to see that in ancient times no light could enter, except through the portal. It was

doubtless imagined that the darkness prevailing in the temples struck those who entered with reverential awe. Hence, too, we may derive the use of lamps in the sanctuaries" (v. Rosenmüller).

Again, in the inside of the Holy Temple in Jerusalem, to which the daylight was not admitted, a solemn darkness always prevailed, relieved only by the *faint* light of some of the lamps "and the candlesticks, five on the right side, and five on the left, before the oracle, of pure gold; and the flowers and the lamps"* (1 Kings vii. 49; 2 Chron. iv. 7).

In the temple of Herodes the religious awe was irresistible. An infinite mysterious dim light fell from the seven branched candlestick (*v.* Joseph I. i. § 5, Rel. *ibid.*, § 25, and de spoliis, &c., p. 82). Every morning before daybreak a priest repaired to an elevated part of the temple, to observe the morning dawn. As soon as he perceived it, he exclaimed: "It grows light." Thereupon the priests, who had to officiate in the sanctuary that day, cleaned the candlestick, and extinguished four of the lamps, for during the day only three lamps were kept burning, as Josephus informs us, (Antiqu. b. III. cap. 8, § 3). All seven were lighted in the evening, and burnt through the night till the morning dawned.

We need not wonder that the Samaritans (who "have retained all ancient practices and beliefs which they held long before the rise of Christianity," *v.* M. Gaster in *Transactions* of the Congr. of the Hist. of Rel. I. p. 229) have a place of worship. Kenîsat as-Samira or Bit Allah, the inside of which is illuminated merely by the light from two very primitive chandeliers and a small oil lamp; yet there is something grand and sublime in the dark silence of this place.

In the same way in the Buddhist temples, though the brightest of colours are used, the general effect is softened in the deep gloom of the temple which is dimly illumined only by the entrance door. In the cathedral of Lhāsa the light comes from immediately above the middle or broadest aisle, where a transparent oilcloth serves instead of diffusing glass. By this means the whole temple is lighted; there are no side windows. And only upon the altar itself, stands the temple lamp, mch'od-skon'—a short pedestalled bowl. A cotton wick, fed by melted butter, emerges from a socket in the centre of this vessel. As the great mass of butter solidifies and remains in this condition, the lamp is practically a candle. And this lamp is the only illuminant of the cathedral! (*v.* Waddell, 'The Buddhism of Tibet').

During all ages places of religious worship, temples, and synagogues, cathedrals, convents, mosques and monasteries, churches, chapels, &c., whether, like the Holy Grotto at Subiaco, caverns dug by the saints of old and the "ocean cave" of St. Rule at St. Andrews or buildings of architectural distinction such as the works of San Galla, Brunelleschi or Bramante, &c., all have preserved the mystery of the gloom in all the rude originality of their ancient forms.

Therefore it is entirely legitimate to bear in mind the religious position of people in ancient times, and to make an appeal to the lessons of history.

I am, yours faithfully,

A Correspondent.

(Dr. B. S.)

* It is very doubtful whether they were lit all at once, *v.* Menachot f. 99, I., Reland Pal. I., 7, 8.

The Economical Possibilities of Lighting by Carbon Filament Lamps.

Dear Sir,—I have been much interested in the article by E. G. K. on the above subject in your last three issues, and with your permission I should like to make one or two comments upon it.

I was led to examine this question somewhat closely whilst writing the chapter on carbon-filament lamps in my book on 'Electric Lamps,' and I treated it in exactly the same way as

your correspondent. On pp. 122–5 I summarized the results of these investigations and published curves corresponding to Figs. 8, 12, 13, 14, and 15 of your correspondent's article.* I did not, however, draw any distinction between 100-volt and 200-volt lamps, as your correspondent has quite rightly done; on the other hand, I gave a series of curves corresponding to different lamp prices, and by taking the price at so much per candle (*e.g.*, $\frac{1}{2}$*d.* per candle for a 16 candle-power lamp costing 8*d.*) possibly gave the curves a more general applicability.

I cannot help agreeing with Mr. Paterson that the results obtained by E.G.K. in Figs 8 and 12 hardly do justice to the modern high-grade carbon-filament lamp. For example, the *British Standard Specification for Carbon-Filament Glow-Lamps* requires for 110-volt 16 candle-power 3·5 watt, and 220 volt 16 candle-power 4·1 watt lamps a useful life of 800 hours. Making the 10 per cent allowance to convert the initial watts per candle into average watts per candle these correspond to 3·85 and 4·51 watt lamps according to E. G. K.'s method of reckoning, for which the curves in Figs 8 and 12 show useful lives of 500 hours only. In the same way your correspondent's curves only credit the standard specification "400 hour" lamps with a life of about 320 hours. The standard specification is certainly supposed to represent results obtainable by ordinary high-grade British practice, and I think other published results would bear out the conclusion that your correspondent's figures are too low.

I think one cause of this discrepancy is, as suggested by Mr. Paterson, that E. G. K.'s curves are based on too few tests. Another possible cause, in my opinion, lies in the method by which the results were obtained. Sufficient care does not seem to have been taken to see that all the lamps had the same candle-power; for example, the lamps in Table IV. have an initial candle-power of 25, which is over 50 per cent higher than that of the lamps in Table VI. This would have a great effect on the blackening of the bulbs and if, as is possible, the bulbs were smaller in the former case (the lamps in Table IV. being over-run 8 candle-power, and those in Table VI. 16 candle-power lamps), this effect would be intensified. Moreover, the lamps in Table IV. were run at 120 volts, and those in Table VI. at 100 volts. To obtain really reliable results it is, I think, essential that there should be no difference between the lamps tested, except the difference in watts per candle.

Although these investigations have considerable theoretical interest, I feel very doubtful of the practical value of the results obtained. The most economical efficiency depends on too many variables: it is not only dependent on the cost of energy and the cost of the lamp, but on the supply voltage (which affects the useful life) and the candle-power (which affects both the useful life and the importance of the renewal cost). More than anything it depends on the steadiness of the circuit as it is obviously much more dangerous to use a high-efficiency than a low-efficiency lamp on a circuit subject to serious rises in pressure. For practically the same reasons the determination of the "smashing point" has only a theoretical interest. In this connexion it may be asked, Has it ever been demonstrated that the lamps which give the best result on a circuit where the voltage is regulated, say, within the standard specification limits,* will also give the best results on an unsteady circuit?

I am, yours truly,

MAURICE SOLOMON.

45, Newhall Street, Birmingham.

* As my book was in the press whilst this article was appearing the coincidence is perhaps worthy of notice.

* The Standard specification provides that the excess of pressure during the test shall not exceed $\frac{1}{2}$ per cent. Apparently the amount by which the pressure may fall below the nominal value and the time for which it may remain at such lower value, is left to the discretion of the tester!

Review of the Technical Press.

ILLUMINATION AND PHOTOMETRY.

On March 8th the concluding CANTOR LECTURE on MODERN METHODS OF ILLUMINATION was delivered by **Mr. L. Gaster,** editor of *The Illuminating Engineer,* before the Royal Society of Arts. Special attention was bestowed on the subject of school and factory lighting, and the necessity of screening the intrinsic brilliancy of modern illuminants by suitable diffusing shades was insisted upon. One point treated in some detail was the effect of ultra-violet rays on the eyes. The ability of this variety of radiation to cause fluorescence of a barium platino-cyanide screen and the qualities of Euphos glass, which is claimed to absorb the ultra-violet radiation, but yet to allow the visible rays to pass almost unchecked, were demonstrated.

An interesting paper by **S. W. Ashe** (*Elec. World,* N.Y., Feb. 25th) also deals with physiological questions. The writer studies the effect of light of different colours on visual acuity, arriving at the conclusion that the greatest visual acuity is obtained by the aid of light from the blue end of the spectrum. He also makes some experiments upon the effect of light upon the iris-diaphragm of the eye, and states that he has found that visual acuity may be decreased as much as 30 per cent by bright sources being brought into the direct field of view.

There have been a number of editorials published dealing specifically with questions connected with illumination. For instance, *The Journal of Gas Lighting* discusses the VALUE AND FUNCTIONS of an ILLUMINATING ENGINEERING SOCIETY, and comments upon the achievements of the Society in the United States (March 16th).

Other subjects of editorial comment include the announcement of the names of those serving on the sub-committee of the International Electrotechnical Commission appointed to consider the question of AN INTERNATIONAL UNIT OF LIGHT. It will be recalled that the French representatives made a suggestion whereby practical unanimity between Great Britain, France, and the United States might be arranged last year, and this desirable result is still under consideration.

A very interesting item published in a recent number of the *Revue des Eclairages,* is the report presented to the Conseil d'Hygiène de la Seine on the subject of FACTORY LIGHTING. No very definite regulations are prescribed as yet, but a number of practical recommendations are made. For instance, it is insisted upon that lights ought to be kept out of the field of vision, that walls should be light in tint, and that inverted lighting systems should be encouraged.

An article by **A. J. Marshall** deals with INDIRECT ILLUMINATION (*Illum. Eng.,* N.Y., Feb.). In view of the somewhat favourable attitude of the report mentioned above to this system, it is interesting to observe that many engineers, like Mr. Marshall, disapprove of the monotonous general illumination that may result when the surroundings are light in texture.

It is to be observed that the stream of literature dealing with the CALCULATION OF MEAN SPHERICAL CANDLE-POWER is still running. **E. W. Weinbeer** contributes an article dealing generally with the problem, and giving a summary of the work that has been done recently with a view to facilitating calculation from polar curves, (*Elek. Anz.,* March 11th) **Wohlauer** describes the use of the special "FLUXOLIGHT" PAPER, designed for a similar purpose. It may be pointed out in passing that, although it is, of course, desirable to reduce the labour involved in these calculations, it is probable that many illuminating engineers would consider the process of obtaining the polar curves from which such methods primarily derive their information, to be even more tedious.

A recent number of *The Gas World* also contains an abstract of the communication by **Krüss** on a NEW FORM OF INTEGRATING PHOTOMETER, that was described last year in the *Journal für Gas,* &c. This photometer utilizes a series of mirrors inclined at suitable angles, in conjunction with a corresponding train of lenses, each provided with a specially calculated stop.

Lastly mention may be made of a paper by **Bordoni** (*Atti della Assoc. Elet. Ital.,* March–April), which consists mainly of an elaborate study of the nature of the REFLECTION OF LIGHT FROM DIFFUSING SURFACES.

ELECTRIC LIGHTING.

There are a number of papers summarizing the QUALITIES OF INCANDESCENT LAMPS to record. Thus **M. Blondel** (*Bull. Soc. Int. des Electriciens*, February, 1909) contributes a paper on very similar lines to that delivered before the Electrical Congress in Marseilles last year and mentioned previously in this journal. Another communication from **M. Laporte** in the same publication gives the results of some TESTS ON THE METALLIC FILAMENT LAMPS caried out at the Laboratoire Central d'Electricité. He mentions that no industrial lamp has ever been met with there that yielded 1 watt per bougie; as a rule the specific consumption varied between 1·25 and 1·8. It is also stated that breakage of the filament during life-test almost invariably occurred before the candle-power of the lamps had fallen 20 per cent. On this account, and also because every-day conditions are rarely realized in a laboratory life test, it would seem that the statement of the "useful life" is of only limited practical value.

Yet a third article dealing with the properties of metallic filament lamps is that of **Leonard** (*Lumière Electrique*, February 6th, and 13th).

Sartori (*Elektrot u. Masch*, March 7th) also contributes an interesting résumé on this point. The article contains a very comprehensive diagram connecting intensity, life, &c., with change in pressure applied to the lamp. It is pointed out in this connexion how sensitive these lamps are to fluctuations in P.D., and to rapid heating and cooling. For this reason they are unsuitable for illuminated signs which are automatically turned on and off at regular and frequent intervals. Sartori believes that the efficiency of the metallic lamps can only be explained on the basis of selective radiation.

This last point is treated by **E. P. Hyde** in a paper recently read before the Illuminating Engineering Society (U.S.); this paper contains an interesting discussion of different methods of examining the radiation from an incandescent body with a view to ascertaining whether or no it exercises selective radiation.

Two articles by **Klement** (*E.T.Z.*, March 11th) and VOGEL (*E.T.Z.*, March 4th and 11th) call for mention. The former draws attention to the WEAKNESSES OF THE ORDINARY EDISON SCREW HOLDER, and describes two modified forms recently introduced by the Siemens-Schuckert Co., termed the "Longized" and "Diazed" respectively. **Vogel** discusses the qualities that ought to be possessed by a safe form of hand lamp. He quotes the safety regulations specified by the authorities in Germany, and draws attention, among other points, to the advisability of avoiding the utilization of all naked conducting surfaces liable to be exposed to the touch and to become live owing to possible defective insulation, &c.

Brandt (*Z.f.B.*, March 10th) discusses the merits of LOW-VOLTAGE TUNGSTEN LAMPS, and their chief applications. It may be noted that small 5 watt, 4 candle-power sign-lamps are now becoming extensively utilized in the States for illuminated signs (*Elec. Rev*, N.Y., March 6th).

TUNGSTEN LAMPS FOR STREET LIGHTING form the subject of contributions from **Rhodes** (*T.I.E.S.*, February) and **Schroeder** (*Elec. Rev.*, N.Y., February 27th). The former deals mainly with details of wiring, &c., but describes several typical installations in which small units are installed at frequent intervals comparatively near to the ground. In the discussion following this paper the danger of glare in connexion with such methods was insisted upon. **Schroeder** gives some details of the methods of SERIES LIGHTING used frequently in the United States.

Scarpa (*Atti della Assoc. Elet. Ital.*, January–February) describes some experiments upon the action of ALTERNATING CURRENTS upon the TANTALUM FILAMENT.

GAS, OIL, ACETYLENE, AND OTHER SYSTEMS OF LIGHTING.

Mention may first be made of the THIRD CANTOR LECTURE, delivered by **Mr. L. Gaster** before the Royal Society of Arts on March 1st, which dealt with portable or self-contained systems of lighting, such as oil, acetylene, petrol-air, &c. A considerable number of lamps were exhibited and described. One striking experiment was the immersion of a coil of pipes, through which air-gas was passing, in a freezing mixture; it was demonstrated that no condensation took place under these circumstances. Reference was made to the application of dissolved acetylene to the illumination of buoys and beacons, &c.

An article in a recent number of the *Zeitschrift für Beleuchtungswesen*, contrasting the merits of acetylene and air-gas is of interest. The writer devotes his attention mainly to contesting the statement that trouble is experienced from air-gas systems owing to the condensation in the pipes in the winter. This, he says, was only characteristic of the older systems, and is now avoided by using a mixture of air and vapour that

is not too rich—a calorific value below 3,000 being desirable.

Two communications to the most recent *Transactions* of the Illuminating Engineering Society (U.S.) deserve special mention. **Fulweiler** discusses the vexed questions of FLAME TEMPERATURE and INCANDESCENT MANTLE LUMINOSITY. He discusses the nature of the Bunsen flame, showing how the "velocity of explosion" and the relative proportions of gas and air are connected, and also deals with the origin of the light realized both in luminous flames and incandescent solids. It is interesting to observe that an efficiency of 50 candles per cubic foot is said to be obtainable from some acetylene flames, while the nahpthalene flame is credited with as much as 180 candles per cubic foot ! The author also discusses the whole theory of the radiation from incandescent materials very thoroughly, and the complete and up-to-date series of references by which the paper is accompanied should render it extremely valuable for reference.

R. C. Ware, in the same number, takes a somewhat new line. He discusses the practical illuminating engineering problem of lighting a specified interior so as to comply with certain conditions as regards intensity of illumination—from the standpoint of gas lighting. A considerable amount of numerical data on such interiors has been published, but, for some reason, observers have almost invariably dealt with electric lamps, and there is room for more figures regarding the possibilities of gas.

Several of the important papers presented at the recent meeting of the American Gas Institute, notably that by **C. O. Bond** on 'THE PHOTOMETRY OF GAS,' and the REPORTS OF THE SUB-COMMITTEES dealing with THE UNIT OF LIGHT and CALORIMETRY, are now published in the *Progressive Age ;* to these, however, reference has been made in a previous review. Suffice it to say they merit careful study.

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Klement, W. Zweiteilige Edison-Stopfel mit Durchmesser-Abstufungen (*E. T. Z.*, March 18).
Ladoff, I. Recent Progress in the Voltaic Arc (continued, *Illum. Eng.*, N.Y., Feb.).
Leonard, C. Comparaison des Lampes à Filament de Carbone aux nouvelles Lampes à Incandescence a Rendement élevé (*Lumière Elec.*, Feb. 13 and 27).
Laporte, F. Resultats d'essais effectués au Laboratoire Central d'Electricité sur les Lampes à Filament Metallique (Bull. Soc. Int. des Electriciens, Feb.).
Rhodes, S. G. Streetlighting by Tungsten Lamps (*T. I. E. S.*, N.Y., Feb.).
Sartori, K. Untersuchungen an Glühlampen (*Elektrot u. Masch.*, March 7).
Scarpa, O. Sull'azione della corrente alternata sulle lampada ad incandenza con filamenti in Tantalio (Atti della Assoc. Elettrotec Italiana, Jan.-Feb., 1909).
Schroeder H. Series Tungsten Lighting ((*Elec. Rev.*, N.Y., Feb. 27).
Vogel, W. Elektrische Handlampen für Industrielle u. gewerbliche Betriebe (*E. T. Z.*, March 4, 11).
Wolcot, E. R. Alternating Currents and their Applications, Lighting Methods (*Elec. Rev.*, N.Y., March 6, 13).
Outline Lighting in Rochester, N.Y (*Elec. World*, March 11).
New Small Bulb, 40 watt Tungsten Lamps (*Elec. World*, N.Y., March 11).
The new Excello Arc Lamp. (*Elec. Engineering*, Feb. 25).

CONTRACTIONS USED.

E. T. Z.—*Elektrotechnische Zeitschrift.*
Elek. Anz.—*Elektrotechnischer Anzeiger.*
G. W.—*Gas World.*
Illum. Eng., N.Y.—*Illuminating Engineer of New York.*
J. G. L.—*Journal of Gaslighting.*
J. f. G.—*Journal für Gasbeleuchtung und Wasserversorgung.*
Prog. Age.—*Progressive Age.*
Phys. Rev.—*Physical Review.*
T. I. E. S.—Transactions of the Illuminating Engineering Society.
Z. f. B.—*Zeitschrift für Beleuchtungswesen.*

OBITUARY.

It is with great regret that we chronicle the death of Major E. L. Zalinski, President of the Bureau of Illuminating Engineering, New York, which occurred on Wednesday, March 10th. Major Zalinski spent many years of his life in the service of the United States Artillery, and was well known for his endeavours in connexion with Illuminating Engineering, and, in particular, the design of scientific reflectors and glassware.

We are also grieved to learn of the death of Mr. A. Granjon, who was one of our valued contributors in Paris, and the author of several articles dealing with different aspects of acetylene lighting which have appeared in recent numbers of *The Illuminating Engineer.*

PATENT LIST.

COMPLETE SPECIFICATIONS ACCEPTED OR OPEN TO PUBLIC INSPECTION.

I.—ELECTRIC LIGHTING.

2,261. Arc lamps. Feb. 1, 1908. Accepted March 10, 1909. A. Holman, 44, West George Street, Glasgow. Post-dated, Sept. 1, 1908.

3,248. Supports for filaments of incandescent lamps. Feb. 13, 1908. Accepted Feb. 24, 1909. H. Hoge and The "Z" Electric Lamp Manufacturing Co., Ltd., 111, Hatton Garden, London.

4,212. Arc lamps. Feb. 25, 1908. Accepted March 3, 1909. H. Baggett, Norfolk House, Norfolk Street, Strand.

10,773. Lamp holders. May 18, 1908. Accepted March 10, 1909. A. F. Rock, 77, Chancery Lane, London.

12,225. Luminous Lighting and bell switches. June 5, 1908. Accepted March 10, 1909. E. S. Conradi, 19, Ebbsfleet Road, Cricklewood.

13,580. Arc lamps (C.S.). June 27, 1908. Accepted March 17, 1909. Siemens Bros. Dynamo Works, Ltd., and C. R. Riber, York Mansion, York Street, Westminster.

14,867. Incandescent lamp filaments. July 13, 1908. Accepted March 10, 1909. The British Thomson-Houston Co., Ltd., 83, Cannon Street, London. (From General Electric Co., U.S.A.).

17,620. Lamp filaments (C.S.). I.C. Aug. 24, 1907, U.S.A. Accepted March 17, 1909. W. D. Coolidge, 83, Cannon Street, London.

18,278. Incandescent lamps (C.S.). Aug. 31, 1908. Accepted March 10, 1909. J. Kremenezky, 18, Southampton Buildings, London.

19,118. Metal filament lamps (C.S.). Sept. 11, 1908. Accepted March 3, 1909. T. McKenna, 31, Basinghall Street, London. (From Glühlampenwerk Anker, G.m.b.H., Germany.)

21,385. Metal filament lamps (C.S.). I.C. Nov. 2, 1907, Germany. Accepted March 10, 1909. Siemens & Halske Akt.-Ges., Birkbeck Bank Chambers, London.

25,557. Glow bodies or filaments for incandescent lamps (C.S.). Nov. 26, 1908. Accepted Feb. 24, 1909. The British Thomson-Houston Co., Ltd., 83, Cannon Street, London. (From General Electric Co., U.S.A.).

1,332/09. Metal filaments (C.S.). I.C. Feb. 22, 1908. Germany. H. Kuzel, 322, High Holborn, London.

2,853. Tungsten and other incandescence filaments (C.S.). I.C. Feb. 11, 1908, Germany. Siemens & Halske Akt.-Ges., Birkbeck Bank Chambers, London. Addition to 4,814/08.

II.—GAS LIGHTING.

18,424/07. Igniting incandescent burners or lamps. Aug. 15, 1907. Accepted March 17, 1909. J. Lewis, Forth Street, Newcastle-upon-Tyne. Post-dated March 16, 1908.

2,816. Lighting and extinguishing gas lamps. Feb. 7, 1908. Accepted March 17, 1909. E. H. Elton and R. Stephens, 27, Chancery Lane, London.

4,415. Gas lamps and burners. Feb. 27, 1908. Accepted March 3, 1909. G. Helps, Izon's Croft, Ansley, near Atherstone.

4,661. Incandescent lamps. March 2, 1908. Accepted March 3, 1909. H. R. Prosser, 5, Corporation Street, Birmingham.

8,573. Incandescent burners. April 16, 1908. Accepted March 10, 1909. H. R. Prosser, 5, Corporation Street, Birmingham.

10,284. Inverted incandescent burners. May 12, 1908. Accepted March 17, 1909. E. J. Shaw, 60, Queen Victoria Street, London.

10,321. Inverted incandescent lamps. May 12, 1908. Accepted March 17, 1909. L. Zechnall, 70, Chancery Lane, London.

10,595. Anti-vibrators for incandescent burners. May 15, 1908. Accepted Feb. 24, 1909. W. Sugg & Co., Ltd., and E. S. Wright, 6, Bream's Buildings, Chancery Lane, London.

12,318. Inverted incandescent lanterns (C.S.). I.C. June 8, 1907, Germany. Accepted March 10, 1909. A. Luber, 77, Chancery Lane, London.

12,905. Globe-holders for inverted incandescent burners (C.S.). June 16, 1908. Accepted March 10, 1909. G. A. Akers, C. W. Akers, and A. E. Akers, 88, Chancery Lane, London.

13,439. Flash-light apparatus (C.S.). June 24, 1908. Accepted March 3, 1909. M. L. Krimer and G. A. Tee, 165, Queen Victoria Street, London.

13,828. Metallic incandescent mantle for lighting and heating (C.S.). June 30, 1908. Accepted March 3, 1909. H. Reeser and H. E. Bray, 20, Copthall Avenue, London.

17,596. Incandescing bodies (C.S.). Aug. 21, 1908. Accepted March 10, 1909. M. von Unruh, 47, Lincoln's Inn Fields, London.

19,731. Incandescent burners (C.S.). Sept. 19, 1908. Accepted March 3, 1909. F. W. Marillier, E. H. Still, and A. G. Adamson, 46, Lincoln's Inn Fields, London.
683/09. Reflectors for gas lamps (C.S.). I.C. March 9, 1908, Germany. J. Hardt, 65, Chancery Lane, London.
3,171. Catalytic material for automatic ignition of illuminating gas (C.S.). I.C. March 5, 1908, France. C. Lubeck, 70, Chancery Lane, London.
3,941. Lighting and extinguishing gas lamps (C.S.). I.C. March 3, 1908, Germany. O. Leopold, 322, High Holborn, London.
3,948. Inverted incandescence lamps (C.S.). I.C. Feb. 17, 1908, Germany. E. W. Küttner, 4, South Street, Finsbury, London.

III.—MISCELLANEOUS.

391. Incandescent lamps. Jan. 7, 1908. Accepted Feb. 24, 1909. J. Stott, 62, Grains Road, Shaw.
4,208. Oil or gas lamps. Feb. 25, 1908. Accepted March 3, 1909. F A. Lewis and R. S. Pike, 41, Earlsfield Road, Wandsworth, London.
4,260. Search lights, motor-car lamps, &c. Feb. 25, 1908. Accepted March 3, 1909. H. Salsbury and T. Whitaker, 18, Southampton Buildings, London.
6,115. Lamps or lanterns. March 19, 1908. Accepted March 3, 1909. J. Hofmann, A. Koester, and F. Kumpernass, 111, Hatton Garden, London.
7,240. Street and other lamps or lanterns. April 2, 1908. Accepted March 17, 1909. H. Sparks, 41, Mount Pleasant Road, Hastings. Post dated Sept. 22, 1908.
8,509. Lighting of billiard tables, &c. April 16, 1908. Accepted March 3, 1909. J. H Faulkner, 111, Hatton Garden, London.
14,657. Search lights. July 10, 1908. Accepted March 10, 1909. Siemens Bros. Dynamo Works, Ltd., and G. S. Grimston, 139, Queen Victoria Street, London.
16,331. Illuminated advertising devices (C.S.). Aug. 1, 1908. Accepted Feb. 24, 1909. F. W. Bundy, 8, Portugal Street, Lincoln's Inn, London.
3,763/09. Reflecting devices for use in photographic studios (C.S.). I.C. Feb. 18, 1908, Germany. A. Iser, 231, Strand, London.
4,044. Lamp shade holders (C.S.). I.C. Feb. 25, 1908, U.S.A. J. Cruikshank, 40, Chancery Lane, London.

EXPLANATORY NOTES.

(C.S.) Application accompanied by a Complete Specification.

(I.C.) Date applied for under the International Convention, being the date of application in the country mentioned.

(D.A.) Divided application : date applied for under Rule 13.

Accepted.—Date of advertisement of acceptance.

In the case of inventions communicated from abroad, the name of the communicator is given after that of the applicant.

Printed copies of accepted Specifications may be obtained at the Patent Office, price 8*d*.

Specifications filed under the International Convention may be inspected at the Patent Office at the expiration of twelve months from the date applied for, whether accepted or not, on payment of the prescribed fee of 1s.

N.B.—The titles are abbreviated. This list is not exhaustive, but comprises those Patents which appear to be most closely connected with illumination.

We are compelled, owing to want of space, to hold over our review of Mr. Maurice Solomon's work on Electric Lamps, which we hope to publish in our next number.

TRADE NOTES.

Messrs. Siemens Brothers' Dynamo Works, Ltd., inform us that on Friday, April 2nd, their Incandescent Lamp and Fittings Department will be removed to much larger premises at Tyssen Street, Dalston, N., in order to cope more effectively with their increasing business. All communications referring to the above matters, previously addressed to 6, Bath Street, City Road, E.C., should after that date be sent to their new address at Dalston.

Messrs. G. M. Boddy & Co., Ltd., inform us that recent tests of the *Metallik* lamps at Woolwich Arsenal have led to very satisfactory results, and that the name of the firm has now been placed on the War Office list.

The Metallic Seamless Tube Co., Ltd., send us an illustrated description of the "*Facile*" two-part lamp-holder case, which, it is claimed, simplifies the coupling up of the holder and permits of an improved method of securing the cord-grip.

The Schiersteiner Metallwerk Co. (Berlin), send us particulars of their clock-work controlled switches for use with illuminated show-windows, on staircases, &c.

The ILLUMINATING ENGINEER

ELECTRICITY · ACETYLENE · OIL · GAS

Edited by LEON GASTER

THE JOURNAL OF SCIENTIFIC ILLUMINATION.

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EDITORIAL.

A Year's Progress in Illuminating Engineering.

THE March number of our esteemed contemporary the *Illuminating Engineer*, of New York, marks the commencement of the fourth year of publication of that journal. The number is naturally largely concerned with a review of the past year's progress and contains a cordial expression of congratulation on the formation of the Illuminating Engineering Society in this country, and good wishes for the British *Illuminating Engineer.*

We need not say that we heartily reciprocate the goodwill of our contemporary, and that we hope and believe that the very generally appreciated pioneering work that it has carried out during the past three years will receive even more emphatic recognition in the future.

Meantime it is interesting to observe several respects in which the movement in the United States has been making yet further progress, and there are clear indications that illuminating engineering is now recognized as something that has come to stay and must be taken seriously. When the movement was in its infancy, it is stated, the gas interests were inclined to hold aloof. This attitude, however, is rapidly becoming a thing of the past. Many of the leading manufacturers of gas lamps and appliances are now organizing special departments of illuminating engineering, and the industry as a whole is now taking a close interest in the doings of the Illuminating Engineering Society.

Mr. W. J. Clark, of the Westchester Lighting Co., in some remarks contributed to the number of our contemporary of which we are speaking, lays stress on the unique nature of the exchange of courtesies between the Illuminating Engineering Society and the National Commercial Gas Co. Association, on the occasion of the Exhibition in Chicago held by the latter at the end of last year. The members of the Illuminating Engineering Society were the guests of the Association at its banquet and subsequently the members of the National Commercial Gas Association present attended the evening meeting of the

Illuminating Engineering Society *en masse.*

Mr. E. N. Wrightington, of the Boston Consolidated Gas Co., and Mr. C. W. Hare, of the United Gas Improvement Co., of Philadelphia, refer to another respect in which the gas industry has shown its recognition of the value of illuminating engineering principles. It seems to have been recognized that the fixtures in common use for gas-lighting were capable of considerable improvement both from the artistic and practical illuminating engineering standpoints, and we are probably justified in supposing that this desire for improvement is more or less directly traceable to the higher standard being gradually introduced by the illuminating engineering movement.

The series of expressions of opinion, collected by our contemporary from different gas and electrical authorities in the United States respecting the progress of the past year, makes interesting reading. All, however, furnish indication of the ever-growing recognition of the claims of good illumination and of the efforts that are being made in all directions to induce the public and the city authorities to take an interest in the subject. It ought indeed, as Mr. E. L. Elliott suggests, to be a matter of civic pride for the public lighting of a city to be maintained in a thoroughly up-to-date and efficient manner. The conditions of street lighting in some of the cities of the United States have been the subject of recent criticism at the hands of Dr. Louis Bell and others, and the Illuminating Engineering Society will be accomplishing a most serviceable piece of work of raising the standard in their own country, and, indirectly, stimulating developments in Europe at the same time.

The visits which various experts in illuminating engineering in the United States have paid to Europe during the past year, with the object of studying street-lighting and other matters, may be regarded as an indication that engineers in the States recognize that they can learn from our experience. We may be confident, however, that this knowledge will be turned to good practical account, and that we, in turn, will also be able to learn much by watching the progress of our friends across the water.

The Illuminating Engineering Society.

The reception of the announcement of the formation of the Illuminating Engineering Society, in the technical press, has been very gratifying, and the news has aroused general interest. We reproduce elsewhere a recent editorial notice in the *Electrical World*, of New York, in which the value of an Illuminating Engineering Society in this country is recognized in very kindly terms and good wishes are expressed for its future.

We need not say how gratifying and encouraging such goodwill always is to those embarking upon a new venture, the more so because it is penned by those who have successfully passed through such initial difficulties as are likely to be experienced in this country, and who are in a position to speak with knowledge and experience regarding the usefulness, future possibilities, and ultimate success of such a society.

Meanwhile it need not be supposed that the friends of the society have been idle. The Committee for the purpose of considering the drafting of statutes, &c., has held several meetings, and it is hoped that the society will be in a position to commence its session in the autumn of the present year.

The opportunity may be taken of again cordially inviting all who are interested in the welfare of the movement and would like to become members to communicate with the hon. secretary. A considerable number of applications have been received since the announcement of the formation of the society, in addition

to the large number of supporters of earlier date, including applications from quarters as far distant as East India and Africa, and there seems every reason to suppose that it will start with a very representative roll of members.

We should also like to refer to one matter which some of those who have discussed the subject of illuminating engineering, and the projected Illuminating Engineering Society in this country, have overlooked. The mere comparison of the relative merits of different illuminants —the attempt to decide when it pays to use gas and when electricity, for example—forms but a small portion of the entire scope of illuminating engineering, and there are many other questions which are of vital importance and of very great interest to those connected with all systems, and which, therefore, need not form the subject of prejudiced controversial discussion. The recognition of the many common points of interest between representatives of different systems of lighting should do much to reassure those who seem to fear that an Illuminating Engineering Society must be the arena of perpetual wrangling between trade opponents.

A glance over the publications of the Illuminating Engineering Society in the United States will reveal the fact that but a small fraction of the papers presented deals with subjects that could be regarded as at all stimulating to "partisan" discussion. Naturally, some such papers on progress in recent illuminants there must be, but the majority deal with general problems in illumination and photometry. Only a few of the eighteen papers read at the Convention of the Illuminating Engineering Society last year dealt with practical progress in particular illuminants, and even these, it may be remarked, do not seem to have occasioned any quarrelsome discussion nor elicited anything more than a general thirst for information.

We may, therefore, anticipate that the same harmonious co-operation will be characteristic of our Illuminating Engineering Society in this country, and that the international character of its membership may be instrumental in establishing the same feeling of good fellowship throughout Europe.

The Eyesight of Wireless-Telegraphy Operators.

The note on this subject by Dr. Bellile, recently published in *Archives de Medicine Navale*, and referred to in our last number, comes as an interesting confirmation of the assertions of Dr. Schanz and Stockhausen and others regarding the injurious effect of extreme exposure to ultra-violet radiation. A number of cases of eyesight-trouble are recorded; ulceration of the cornea and other defects are ascribed to the action of the radiation of short wave-length in the intense spark used in wireless transmitters. Attempts are being made to standardize a type of spectacles for the safeguarding of the eyes of workers in the future.

The injuries referred to seem to be regarded as mainly attributable to ultra-violet radiation. The author, however, seems to consider it also possible that there may be some deep-seated objectionable physiological effect on the human organism of the wireless electro-magnetic waves themselves.

The note is concluded by a paragraph pointing out how many triumphs in physical science, such as the discovery of the Röntgen rays, have proved to be accompanied by insidious possibilities of physiological injury. Unfortunately the effect as a rule only comes on gradually and is not recognized in time. Later workers in such fields reap the benefit of early sufferers and learn to protect themselves; but there are, unfortunately, not a few martyrs among the pioneers, to whom the chief credit of the scientific results attained is usually due.

It is natural, therefore, that there should be some concern among the medical profession regarding the effects of untried illuminants emitting a quality of radiation differing considerably from that of the older sources of light. If any such corresponding source of injury exists, the matter is of much graver importance on account of the large number of people concerned. Therefore the peculiarities of new illuminants should be the subject of careful study in order that we may detect any possible source of trouble at an early stage and take due precautions to avoid evil consequences, while benefiting from the practical improvements which their introduction brings about.

The Report of the Conseil d'Hygiene de la Seine on Factory Lighting.

The report of the Conseil d'Hygiene de la Seine, which will be found elsewhere in this number, on the above subject is of considerable interest at the present moment.

We have repeatedly called attention in these columns to the obvious desirability of supervising the conditions of illumination in factories. It seems only reasonable to contend that good lighting is as essential to the well-being and convenience of employees as good sanitation and adequate ventilation, and this view is also gaining ground in this country.

It is, therefore, striking evidence of the general recognition of the correctness of our view that some action is necessary, to find that our neighbours in France have taken the matter up so energetically. The report in question seems quite naturally to be guarded in its tone, and, we think, very wisely so. The matters touched upon, while exceedingly important, offer somewhat debateable ground for discussion. While certain recommendations are put forward, it is decided to impose no actual regulations before the subject has been more thoroughly studied. It is to be noted, however, that the opinion is unhesitatingly expressed that all bright sources should be kept completely outside the range of view of workers. Stress is also laid on the necessity for providing sufficient intensity of illumination in order to enable workers to see their task properly.

Seeing that, in this report, the question of keeping bright sources of light out of the field of view is the subject of strong disapproval, it may even be suggested that the time is now ripe when definite regulations might well be drafted to protect the eyes from exposure of this kind; this view is put forward in the Fourth Cantor Lecture on 'Modern Methods of Illumination,' delivered before the Royal Society of Arts on March 8th, and abstracted in the current number.

The report contains an interesting résumé of legislation of various countries regarding factory lighting, in which, it may be noted, this country does not figure. It is very interesting to observe that Holland alone, according to this report, appears to have prescribed a definite minimum intensity of illumination desirable, namely 10 candle-metres (roughly 1 candle-foot).

It is advised by MM. Chantemesse and Walckenaer that the walls and ceilings of workshops should, when practicable, be painted with some light-tinted material, in order to reflect as much light as possible. It is also recommended that tints of a yellowish nature should be employed in order to absorb the radiation of short wave-length, which is considered injurious to the eye. The recognition that care must be exercised in connexion with the ultra-violet rays present in the newer artificial illuminants, seems to be gaining ground; the matter, however, certainly requires much more study than it has yet received before very definite recommendations are made on this point.

LEON GASTER.

Review of Contents of this Issue.

Mr. A. P. Trotter (p. 295) continues his discussion of PHOTOMETER SCALES and the calibration of photometric benches direct in candle-power. He refers in some detail to the merits of the so-called "COMPENSATION METHOD," by the aid of which want of symmetry in the photometer and other small sources of error are illuminated.

Dr. C. Charitkoff contributes a short note on a NEW VARIETY OF PETROLEUM which he terms "Meteor," the composition of which he describes, and which is stated to resemble the best American Water-white oil as regards its value for purposes of illumination (p. 299)

In the present number a report of the Conseil d'Hygiene dealing with the ILLUMINATION OF FACTORIES AND WORKSHOPS, which was referred to in abstract in our last number, is reproduced in full, communicated by our Paris correspondent. While not suggesting the enforcement of any definite regulations in addition to the existing ones, the report contains a number of recommendations. Chief among these is the advice that very bright sources of light should be invariably placed outside the field of view of workers.

In addition, it is pointed out that workshops illuminated by only artificial means usually suffer both through a tendency to vitiation of the atmosphere, and owing to indirect consequences of prolonged exclusion of sunlight. An interesting feature in this report is a résumé of the legislation of a number of countries dealing with this important question (p. 319).

Dr. R. C. Bohm continues his notes upon INCANDESCENT GAS LIGHTING. Having completed his remarks upon the Ramie and the ordinary cotton types of mantles, he now turns his attention to mantles of artificial silk, and describes a series of patents explaining the process by which such mantles are made (p. 326).

Prof. H. Strache (p. 329) contributes an article dealing with HIGH PRESSURE INCANDESCENT GAS LIGHTING. He explains the basis of the efficiency derived by such methods, and refers to the work of Bunte, Teichel, Mayer, St. Claire Deville, and others who have studied the various factors upon which the necessary perfect mixture of gas and air depends, and deduced the theoretically perfect proportions. He gives some figures of the efficiency attained recently in this country and in Germany, and refers briefly to some of the chief modern systems of high pressure gas distribution

The paper by **Dr. E. P. Hyde**, entitled A STUDY OF SELECTIVE EMISSION FROM INCANDESCENT LAMPS, is continued in the present number (p. 335). The author proceeds to describe several methods by which, he suggests, an idea can be formed as to whether the efficiency of the filament depends upon selective radiation, and describes some experiments from which the conclusion is derived that some degree of selective radiation is almost invariably present.

The fourth and last of the series of Cantor lectures on MODERN METHODS OF ILLUMINATION, delivered by **Mr. L. Gaster** before the Royal Society of Arts, is abstracted in this number by the kind permission of the Society (p. 301). This lecture deals with general problems of illumination. It is pointed out that artificial light is used to-day to a much greater extent than formerly, and care should be exercised in its employment. A comparison is drawn between artificial and daylight illumination, both of which, however, require very careful study in the case of many important public buildings, and a résumé is given of recent progress in photometry. The necessity of screening bright sources of light is dwelt upon, and an account is given of modern methods of diffusing and distributing light by suitable shades. Some recom-

mendations are then given regarding the lighting of schools, factories, barracks, churches, &c.

Finally, a series of experiments are described showing the nature of ultra-violet light, and the possibility of screening it by means of the newly invented Euphos glass. It is pointed out that the quality of radiation yielded by modern sources of light differs considerably, and that care should therefore be exercised in utilizing any very peculiar and untried variety of illumination differing very markedly from daylight.

Among other articles in this number may be mentioned a communication by our French correspondent dealing with the PRESENT STATE OF METALLIC FILAMENT LAMPS (p. 333). After detailing the chief methods by which these lamps are manufactured, the writer refers to some researches carried out at the Laboratoire Central d'Electricité dealing with the life of such lamps ; it is pointed out that industrial conditions are rarely in accord with those under which life tests are made, and that metallic filament lamps usually give way before a diminution of 20 per cent in candle-power is reached.

Another article (p. 316) contains some notes on the EARLY DEVELOPMENTS OF GAS LIGHTING in the streets of London. The author describes the struggle of Winsor and other early pioneers in this field, and shows how any new movement is usually opposed by vested interests, but may, nevertheless, eventually prove successful.

Among other items, reference may be made to a short article discussing the nature of FIXTURES for BEAUTIFUL INTERIORS. It is pointed out that the lighting should be carefully studied with reference to its surroundings.

Some short notes are contributed by a German correspondent, describing the co-operation in that country between different trades connected with illumination, and announcing the REJECTION OF THE PROPOSED TAX ON LIGHT.

An Engineering Correspondent describes (p. 340) some experiments on GROWTH AND DECAY OF COLOUR SENSATIONS, carried out with the "Benham disc." He shows that the different colour sensations decay at a different rate, and that this may explain the colours perceived when the disc referred to is rotated ; this phenomenon may have a bearing on the theory of flicker-photometers and other cases of fluctuating illumination.

Prof. L. Weber contributes a letter to the correspondence columns of the present number dealing with the question of the EFFECT OF LIGHT OF DIFFERENT COLOURS ON VISUAL ACUITY (p. 345). He describes a series of experiments made under his direction comparing the results obtainable by the methods of equality of brightness, flicker, and acuteness of vision, and states that the results arrived at are very discordant. He recommends the use of red and green glass, as previously specified by him, as a means of comparing lights of different colours. If need be the coloured glasses may be utilized in connexion with either of the three methods mentioned above, an appropriate reference-table of constants being predetermined and applied in each case.

Another correspondent contributes a letter on the subject of the INTERNAL LIGHTING OF CHURCHES (p. 347). He points out that, under modern conditions, it is not to be expected that we should rely exclusively upon the primitive systems of lighting characteristic of the most ancient temples and religious buildings, and doubts whether conditions of illumination of such ancient origin are adapted to the religious position of to-day. In any case the requirements of different types of religious buildings may be found to vary considerably according to the religious observances and nature of worship carried on therein.

At the end of this number will be found the usual **Review of the Technical Press** (p. 355), **Reviews of Books** (p. 359), and the **Patent List** (p. 360).

TECHNICAL SECTION.

[*The Editor, while not soliciting contributions, is willing to consider the publication of original articles submitted to him, or letters intended for inclusion in the correspondence columns of 'The Illuminating Engineer.'*

The Editor does not necessarily identify himself with the opinions expressed by his contributors.]

Illumination, Its Distribution and Measurement.

By A. P. Trotter,

Electrical Adviser to the Board of Trade.

(*Continued from p.* 225.)

For ordinary measurements of lamps, the method of double weighing, with simple scales of squares, is the most convenient. The scales may be arranged as in Fig. 70, the graduations being the same as those in Figs. 63 and 64, but arranged right and left of zero. For commercial work it is usual to divide the scale into quarter candle-powers in the neighbourhood of 16 candle-power. For scientific work it may be carried to decimals. The standard lamp is placed on the left, over the graduation corresponding to its known candle-power. The photometer head is fixed at zero, and the lamp to be measured is moved along the scale on the right, until a balance is found. An index attached to the lamp-carrier gives the candle-power.

The method of compensation presents several advantages. A working lamp and a standard lamp are generally used. The working lamp may be an electric glow-lamp with some sensitive form of instrument for indicating, but not necessarily for measuring, the current, and with an adjustable control of the current; or a good paraffin lamp may be used, provided that it has been burning for at least a quarter of an hour before use. The standard lamp may be a Hefner or a Harcourt lamp, or an electric glow-lamp giving a known candle-power with a known and carefully measured current; no voltmeter is needed. The photometer head is fixed at zero on a scale such as that shown in Fig. 70. The working lamp is put on the left, and the standard is set at its known candle-power on the right. The working lamp is then moved until the photometer gives a balance, and then it is fixed. The standard lamp is removed and put away until it is desired to check the working lamp. Lamps to be measured are moved on the right of the photometer, and when a balance has been found, the candle-power is read directly on the scale. In this method, the candle-power of the working lamp need not be known, and the left-hand part of the scale need not be graduated. It is only necessary that the working lamp shall not vary in candle-power during the work.

Such an arrangement has the advantage that the standard need not be moved along the scale. A Harcourt pentane lamp is, of course, quite unsuitable for being moved, and a Hefner lamp, though comparatively light, is liable to flicker. Besides this it is more convenient to keep the photometer head fixed, especially if a Lummer-Brodhun, with a slanting telescope is used. The observer can sit in one place with his notebook at hand, and need not even move his head. The lamp to be tested is

mounted on a movable carriage worked by a cord or a light rod. This is the arrangement recommended by Dr. J. A. Fleming,* and is used at the Edison & Swan factory.

But sometimes the lamp to be tested cannot be moved. Owing to the shape of the filament of an electric glow-lamp, and to reflections from the glass bulb, the candle-power is not the same in all directions. One of the methods for obtaining the mean horizontal candle-power is to spin the lamp by means of a motor; another is to surround the lamp by a number of mirrors which reflect the light on to the photometer. A method for obtaining the mean candle-power in all directions is to enclose the lamp in a large globe painted white inside. The lamp itself is not visible from the photometer, but the diffused light is measured. When such appliances are used it is inconvenient or impracticable to move the lamp under test. Metal filament lamps as at present made are often so brittle that it is not desirable either to move them or to rotate them.

In order to retain the principle of a fixed distance between the working lamp and the photometer head, these must be attached together by a rod after the adjustment has been made against the standard, and they must be moved together along the scale. The standard lamp S (Fig. 71) is first

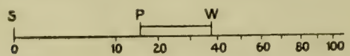


Fig. 71.

placed over the zero of a simple scale of squares, and the photometer head P is placed over the number corresponding with the known candle-power of the standard. The working lamp W of any convenient candle-power is moved on the right until a balance is obtained, and it is then clamped by the connecting rod to the photometer head. The standard lamp is then removed, and the lamps to be tested are put successively in its place. The pointer for the scale is attached to the photometer head.

If for any reason, both the lamp to be measured and the photometer head are to remain fixed, then the working lamp must be moved, unless some other means, such as those to be described later, are used for adjusting the illumination of the photometer. If the working lamp be moved, a scale of reciprocals of squares must be used

To prepare this, Barlow's tables are useful. Let 10 candle-power be indicated at 1 metre. To find the position of the graduation indicating 1·1 look out the nearest reciprocal to 1,100,000, this will be found to be 1,100,110, and is the reciprocal of 9,090. The number 9,090 does not concern us, but its square root, 95·3415 gives the distance of the graduation, namely 953·4 millimetres.

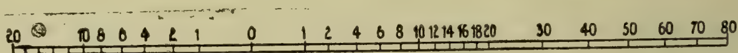


Fig. 70. Double Scale of Squares.

In the process of double weighing, the object to be weighed is first counterpoised, and is then taken out of the scale pan and weights are added until the counterpoise is balanced. The weight of the counterpoise and the ratio of the lengths of the arms need not be known. But in this double photometric method it is important that the photometer head shall be so placed with respect to the zero of the scale, that the law of the squares of the distance is satisfied. When a movable photometer is used on a ratio scale as in Fig. 68, it is not only necessary that the index shall be carefully fixed with reference to the head, whatever type of photometer be adopted, but the head or at all events its essential part, such as the disc of a Bunsen photometer, should be reversible, and reversal should not affect the balance. With the method of

* Fleming, *Journal Inst. Elec. Engineers*, Vol. 32, p. 143.

double weighing this reversibility is not necessary, and want of symmetry to which many kinds of photometers are liable, does not introduce error. When the lamp to be measured is of approximately the same shape and candle-power as the standard lamp, errors due to stray light practically disappear, but precautions should always be taken against this fault.

The method of keeping a fixed distance between the photometer head and the working lamp has a considerable advantage over the older method of moving the photometer head between two fixed lamps, because the illumination of the screen, whatever type of photometer is employed, is constant. That illumination can therefore be chosen which gives the highest accuracy. No careful investigations seem to have been made to discover the best illumination. It probably differs with different kinds of photometers. The Gas Referees use a distance of 1 metre between the 10 candle-power lamp and the photoped, giving 0·93 foot candle. But they observe the light *through* the paper screen. The brightness of their screen as seen, when in balance, is as though it received about 0·28 foot candle illumination from the observer's side. Prof. Fleming uses a 16 candle-power lamp at 4 feet, giving 1 foot candle, and Mr. C. C. Paterson at the National Physical Laboratory uses 10 candle metres. In these two last cases, Lummer - Brodhun photometers are used. The field as seen by the observer is considerably less bright than a white surface illuminated with 0·93 foot candle, not only in consequence of the various reflections and prisms, but by the magnification of the image by the microscope. In a careful examination of the accuracy to be obtained from various types of photometers, Messrs. Kennelly and Whiting* used a 5 metre bar, and two 16 candle-power lamps, giving only 0·24 foot candles. Hugo Krüss, writing in 1886,† discusses the best length for a photometer bar. He recommends at least 5 metre-candles, say, half a foot candle on the screen. He suggests 2·08 metres for 10 candle-power, and 2·74 metres for 20 candle-power. He was probably working with two candles on one side and a 10 or 20 candle-power gas burner on the other. It is probable that not only the type of photometer, but the preference of each particular observer should be taken into account in deciding the best working illumination. The fixed distance method gives complete freedom for choice in this matter.

If we take squares of inches calling 10 inches 1 candle-power, and 40 inches 16 candle-power, the graduations may be found from Barlow's tables, taking 40 as the square root of 1,600, 39·749 the square root of 1,580, and so on. If 48 inches is taken for 16 candle-power a scale of decimals of a foot should be used. 1 candle-power is then at 1 foot. If the metric scale is adopted, 16 candle-power will be at 126·49 mm. The square root of 160 is 12·649.

If the working lamp is of 16 candle-power, a 100 inch bar would only allow 16 candle-power as a maximum on the measuring side. But there is no reason for using a working lamp of candle-power of about the same magnitude as the lamps to be measured. It is sometimes asserted that for good work the ratio between the two lamps should approach unity, but it is difficult to find any adequate reason for this assertion. It is impossible to tell by looking into a photometer head when adjusted for a balance whether the ratio of the candle-powers is more nearly 1 to 1, or 1 to 100, or 100 to 1. Care must be taken to adjust the position of the lamp to be measured, with respect to the pointer on the scale, but no pointer or scale is necessary for the working lamp when the method of double weighing is used.

With the old-fashioned arrangement of a lamp fixed at each end of the bar, and a photometer head moving between them, it is true that the scale becomes contracted at the high candle-powers, and considerable care must be taken

* National Electric Light Association, New York, May, 1908.

† Schilling's *Journal für Gasbeleuchtung*, 1886, p. 893.

that the standard lamp is exactly over the end of the scale.

With a scale of squares for the Compensation Method, a working lamp of 10 candle-power and a lamp under test of the same candle-power, one being 1 metre to the right and the other 1 metre to the left of the photometer head, a displacement of 24·7 mm. is equivalent to a change of 5 per cent in the candle-

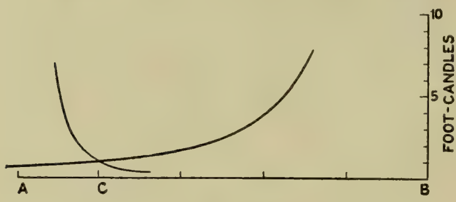


FIG. 72.

power of one of the lamps, but if the lamp under test is of 50 candle-power, a displacement of 5·5 mm. is equivalent to a change of 5 per cent. There is, however, no greater difficulty in obtaining a good balance in the latter case than in the former.

In any photometrical arrangement depending on the law of the squares of the distances, the decrease of the illumination on a screen at greater and greater distances may be represented graphically by a curve, the tangent to which, at any point, is an illumination gradient. The law of squares is true only when the source of light is a point, but the error is less than 1 per cent when the greatest cross dimension of the source of light is less than one-fifth of the distance to the screen.

Let A B be a photometer bar of the old-fashioned type with a single candle at A and 16 candle-power at B. At the point C, one foot from A, the candle will produce an illumination of 1 foot-candle, and at the same point the 16 candle-power lamp will produce the same illumination. The whole essence of ordinary photometry is to discover this point C at which the illuminations are equal, and thus to calculate the ratio of the candle-powers. The curves are curves of illumination, the ordinates are in foot-candles. The gradient of illumination at C due to the 1 candle is 2 foot-candles per foot, and that of the 16 candle lamp is half a foot-candle per foot.

(To be continued.)

Illumination at the Royal Institution.

SEVERAL of the subjects treated at the evening meeting at the Royal Institution on April 23rd were closely connected with illumination.

A lecture was delivered by Mr. Alexander Siemens on the properties and uses of the metal tantalum. Naturally, the application of this metal in the tantalum lamp was the use to which the lecturer made fullest reference, and a number of experiments were shown illustrating the essential differences of the tantalum from the carbon filament. Some description was also given of some less known uses of the metal for which its hardness and flexibility render it of value, such as fine tools, surgical and scientific instruments, and pen-nibs.

Among the various exhibits on view after the lecture, mention may be made of the demonstration by Mr. Leon Gaster of the use of the "Euphos" glass, invented by Drs. Schanz and Stockhausen, in order to absorb ultra-violet energy, and of the qualities of chimneys and electric lamp-bulbs made of this glass. The Trotter Universal photometer and the adjustable portable Siemens photometer were also on exhibition, and a number of slides representing different forms of photometrical apparatus, &c., and charts for the purpose of comparing the power of different illuminants to reveal detail, were shown by Mr. Leon Gaster and Mr. J. S. Dow respectively. Mr. Dow also arranged a demonstration intended to show that the "power of creating brightness" and the "power of revealing detail" of a source of light were distinct functions, red being preferable to blue as regards visual acuity, for moderate distances of the eye.

The Meteor Illuminating Oil.

By Prof. C. Charitkoff
(Director of the Railway Laboratory at Charkoff, near Grossny, Russia).

In Baku and Grossny the name "Meteor" is used to describe the Baku variety of which a certain illuminating oil has the following properties :—

Specific Gravity 0·806 to 0·810 (at 15° C.)

Flashpoint not less than 28° C.

Colour-grade according to Stammer, 1·5.

The corresponding Grossny illuminating produce has a lower specific gravity (0·79 to 0·8), and corresponding properties as regards flashpoint, &c.

The difference between the varieties is due to a variation in the method of production and the materials employed. As is well known the Grossny naphtha is characterized by a considerable proportion of easily volatilized hydrocarbons. The Meteor is prepared by secondary distillation of the gasoline and the other easily distilled intermediate products, according to the following scheme :—

Below 0·730, *Heavy Benzines.*

0·730 to 0·755, *Benzines and other products suitable for heating purposes.*

Residue-distillate consists of raw Meteor. This is passed through suitable cooling apparatus, refined by the action of sulphuric acid and caustic soda, and subsequently clarified. Naturally such a distillate containing, as it does, but little unsaturated hydrocarbons, only demands very restricted treatment with reagents.

In Baku, on the other hand, the Meteor is manufactured by immediate distillation of the raw oil as first distillate, *i.e.*, by limiting the proportion of petroleum constituents and excluding the hydrocarbons which only distil at a high temperature (solar oils). The accompanying table provides a comparison of the qualities of Baku and Grossny Meteor.

Variety of Oil.	Specific Gravity.	Per cent Fraction Distilling :—		
		Below 150° C.	Between 150° and 200° C.	Higher than 200 C.
1. Meteor from Baku	0·8106	3·2	60·2	36·5
2. ,, ,, Grossny	0·792	29·28	42·14	28·57
3. ,, ,, ,,	0·798	9·9	53·8	36
4. ,, ,, ,,	0·783	37·77	50·3	11

Like the Baku variety the Grossny Meteor is characterized by a considerable proportion of the hydrocarbons distilling between 150°–200° C. Grossny Meteor, however, contains more carbonaceous constituents distilling below 150° C., and though identical in other respects, possesses a lower specific gravity, as stated above.

No. 4 in the above table refers to a new type of Grossny Meteor ; this is the lightest of the four varieties and contains the smallest quantity of hydrocarbons distilling above 200° C.

The light colour and low specific gravity of the Grossny Meteor resembles that of the finest American "water-white" petroleum. It is specially well adapted for use with the petroleum incandescent burner, for it volatilizes more easily than ordinary illuminating oil, and is very little inclined to carbonize and thus tend to choke up the burner, &c.

In the wick oil-lamp this variety of petroleum yields a very white and steady flame. It is best adapted for use with flat types of wicks, though it has also given satisfactory results with round burners. The writer has made some photometric investigations on this point, and found that the efficiency approached that of ordinary petroleum lamps, involving a consumption of 2·6 to 2·9 gr. per candle-hour.

It may be added that during the year 1907 nearly 25,000 tons of Meteor oil were manufactured in Grossny alone.

Modern Methods of Illumination.

By Leon Gaster.

(Editor of *The Illuminating Engineer.*)

(The following is the Syllabus of four Cantor Lectures delivered before the Royal Society of Arts, Adelphi, W.C., on Monday evenings, February 15th, 22nd, March 1st, 8th, at 8 o'clock, the fourth of which we abstract in this number, by kind permission of the Society.)

Lecture I. — *February* 15. — Electric Lighting.— Introduction — Incandescent Electric Lamps (Historical Summary)— Recent Developments of Nernst—Graphitized, Tantalum, Osmium, Tungsten, Helion, Mercury Carbon, and other Lamps—The Use of Transformers—Effect on the Lighting Industry (Central Stations, Manufacturers, and Consumers)— National Lamp Association and Standard Specification—Lines of Future Development. *Arc-Lamps.*—The Carbon Arc—Open and Enclosed Arc-Lamps—Miniature Arc-Lamps—Flame-Arc Lamps—Open and Enclosed with Inclined and Perpendicular Carbons—Arc-Lamps for Photographic and Medical Purposes—Applications and lines of Future Progress. *Use of Luminescent Vapour and Gases.*— Early Mercury Lamps—Cooper-Hewitt, Bastian, Vogel, Quartz-Tube, Küch, and Uviol Lamps—The Moore System of Luminescent Gases and its Applications

Lecture II.—*February* 22.—Gas-Lighting.—Summary of Early Development of Gas-Lighting—Flat-Flame, Regenerative, and Enriched Gas-Burners—The Coming of the Incandescent Gas Mantle—Its Theory and Action—Soft Mantles and other New Developments—The Hella Bushlight. *High-Pressure Gas-Lighting.* —Selas, Millenium, Sale-Onslow, Pharos, Grätzin, Colonia, Keith-Blackman, Suggs, and other Lamps—Relative Merits of Compressed Air, Compressed Gas, and Mixture of Air and Gas—Self-Intensifying Lamps, Scott-Snell, Lucas-Thermopile, Welsbach, Chipperfield Lamps, &c. Automatic Lighting and Extinguishing at a Distance—Electrical and Pneumatic Devices—Self - Lighting Mantles—Liquid Gas—Blau, Wolf, and other Systems— Modern Problems in Gas-Lighting—Recent Developments in Street Lighting in London and Berlin — Candle-Power Standards *versus* Calorific Power of Gas —Lines of Further Researches : Livesey Professorship at Leeds.

Lecture III.—*March* 1.—Lighting by Candles, Oil, Acetylene, Petrol, Air-Gas, Alcohol, and other Illuminants —The Candle and other Early Systems —The Petroleum Lamp : its Merits and Drawbacks ; Decision of Third International Petroleum Congress *re* Safety of Lamps—Recommendations of using Efficiently the Ordinary Household Lamp —The Petrolite Lamp—High-Pressure Systems of Kitson, &c.—Modern Petrol Air-Gas Systems and their Merits—Examples of several Types and Generators— The Aerogen, Cox Air-Plant, De Laitte, National Air-Gas, &c.—Lighting by Alcohol and other Liquid Fuels—Acetylene : its Early Development and Difficulties Overcome—Modern Types of Burners— Applications to Incandescent Mantles— Liquid Acetylene—Transport Facilities— Lighting of Railway Carriages—Illumination of Buoys, &c.—Summary of Position of Modern Illuminants—Comparisons of Quality for Lighting and Radiant Efficiency—Researches for further Improvements.

Lecture IV. — *March* 8. — General Problems in Illumination and Illumination Measurements. — Daylight Illumination and its Variation during the Day and Season of the Year—Intrinsic Brilliancy of the Different Artificial Illuminants—Effect on the Eye—Methods of shading, Use of Frosted Opal and Holophane Globes and Reflectors—Spectra of various Illuminants—Possible Physiological Effects of Light of Different Colours —New Researches of Effect of Ultra-Violet Light on Sight—The Use of Euphos glass —Modern Methods of Measuring Light and Illumination : Exhibition of some of the Latest Apparatus—International Action regarding Standards and Units of Light—Lighting of Schools, Libraries, Factories, Hospitals, &c.—Illumination and Hygiene—The Work of the Illuminating Engineering Society—The Need of the Illuminating Engineer Expert : Description of his Functions—Concluding Remarks and Recommendations.

Each lecture will be fully illustrated by working specimens of the lamps and apparatus described.

Modern Methods of Illumination.

By Leon Gaster.

IV.—General Problems in Illumination and Illumination Measurement.

(Cantor Lecture delivered before the Royal Society of Arts on March 8th, 1909; the following abstract is made by kind permission of the Society.)

The lecturer commenced by remarking that the three previous lectures had been illustrated by a very representative collection of different systems of illumination, which might be said to offer almost a bewildering variety of choice. In those lectures he had referred to the alteration in modern industrial conditions, the tendency to use more and more artificial light, and to turn night into day, with a facility undreamed of by our forefathers. At the same time this very facility carried with it a degree of responsibility with which our forefathers were not troubled; the present, when developments in lighting were proceeding more rapidly than ever, was a fitting time to take stock of the situation.

We might well ask how much light was required for different purposes, what kind of light was desirable, what direction the light ought to come from, and how it should be distributed. All these were questions that demanded satisfactory answers.

We might, indeed, even go so far as to inquire whether, after all, we were doing wisely in proceeding on this course of turning ' night into day."

Was it not conceivable that we might experience certain physiological actions during the night time which demanded darkness, and that an attempt to reduce the hours of darkness considerably might not be, from this point of view, injudicious ?

Daylight Illumination.

In all these perplexing questions, however, there was perhaps, one guide on which we could rely, even though we must not follow it too implicitly, namely, the qualities of natural daylight, to the best use of which our eyes had been gradually developed through countless generations. Yet here again, it should be remembered that daylight itself must be studied scientifically in order to use it to the best advantage. Both its quality and its intensity differed very greatly in places at different seasons, and at different times of the day. Weber in Germany, and Basquin, Nichols, and others in the United States had studied this question closely.

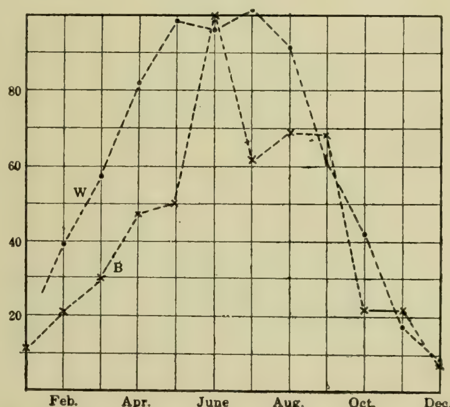


Fig. 1.—Variation in Intensity of Daylight during different months in the year (Basquin and Weber).

Naturally, therefore, provision must be made to secure that daylight illumination of buildings was sufficient to enable people to carry out their work with comfort. Indeed it might even be found that the actual variation in the intensity of illumination in different parts of a room lighted by daylight varied even to a greater extent than when illuminated by artificial light, according to the nature of the windows. Such questions were of vital importance in school-lighting, and the illumination of other important public buildings,

In passing it might be mentioned that Mr. P. J. Waldram had recently been studying the measurement of daylight illumination from the architect's standpoint, and had found actual measurements of very great value in supporting his contentions in connexion with cases of "ancient lights" in court; this was an instance of the unexpected directions in which the value of the measurement of illumination often came to be realized.

The design of window space had received attention from Prof. L. Weber, Prof. Ruzicka and others. A simple and portable instrument, designed by Thorner with the object of comparing the brightness of the sky with the actual illumination in the room produced thereby, was on exhibition (see *Illuminating Engineer*, vol. i. p. 505)

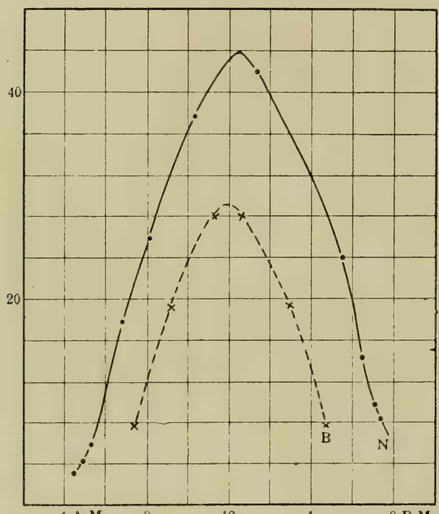


Fig. 2.—Variation in Intensity of Daylight at different hours in the day (Nichols and Basquin).

Naturally all these problems brought in very many factors, including the scheme of decoration of the room. Darkness of the wall papers had a very noticeable effect upon the amount of illumination available.

Intrinsic Brilliancy.

One very important respect in which artificial illumination of the present day differed from daylight was in "intrinsic brilliancy." We had gradually become accustomed to the use of concentrated sources of light far brighter than the brightness of the normal sky. For instance, the following table contained some figures obtained by Dr. Stockhausen and others.

TABLE I.

INTRINSIC BRILLIANCY OF VARIOUS ILLUMINANTS.

(Stockhausen, *Zeit. f. Bel.*, Oct. 10, 1907.

SOURCE.	INTRINSIC BRILLIANCY. (Candle-power per Square Inch of Surface, approx.)
Petroleum Lamp	20
Incandescent Mantle	35
Carbon Filament Glow-Lamp	450
Metallic Filament Glow-Lamp	1,100
Nernst Filament Glow-Lamp	2,250
Arclight (Crater)	17,000

AVERAGE INTRINSIC BRILLIANCY OF SKY.

(Basquin), 3·5 candle-power per square inch.

MINIMUM INTRINSIC BRILLIANCY RECOMMENDED.

	C.-P. per square inch.
Stockhausen.	4·2
Woodwell (Ill., Eng. Soc., 1908)	0·1 to 0·2

It was now realized by those who had studied illumination that this quality of intense intrinsic brilliancy was one of the most inconvenient qualities of modern sources of light. Those present would agree as to the dazzling effect of looking straight at an arc lamp, high pressure gas light, or a naked metallic filament glow lamp at close quarters. After looking steadily at such a source for a few minutes, and then shutting the eyes, a distinct "after-image" was often perceptible, which corresponded with an abnormal and possibly injurious condition of the eye. In a previous lecture he had exhibited some slides, very kindly put at his disposal by Prof. Stirling, of Manchester University, illustrating the delicacy and complexity of the mechanism of the eye. When we recalled of what inestimable importance to us these organs were, we ought to do all in our power to avoid any conditions that might cause them distress.

Bearing in mind the order of brightness of the sky, which Prof. Basquin, in the United States, estimated to be, on the average, in the neighbourhood of 3·5 candle-power per square inch, some authorities had recommended that the intrinsic brilliancy of sources

of light liable to fall in the direct field of vision, should not exceed 5 candle-power per square inch. More recently, however, it had been felt that even this value was excessive in the cases of sources comparatively near to the eye, and Mr. J. E. Woodwell (*Illuminating Engineer*, vol. i. p. 938), had recommended a value of the order of not more than 0·1 to 0·2 candle-power per square inch.

Mr. Gaster did not, however, wish to dwell on this question in any alarmist's manner, but only to point out that this defect of modern illuminants must be faced, and probably could be met by comparatively simple precautions. The obvious moral was that such bright sources ought to be kept out of the field of view of the observer, or, if visible, their brilliancy ought to be suitably reduced by the effective use of shades. Apart from the possibility of physiological injury, common sense told us how absurd it was to try to see any object with a bright source in between this object and the eye. In this connexion he might mention with approval the recent recommendations, from the standpoint of public safety, of the City authorities in specifying that bright sources outside shops, &c., should be screened in the direction facing the street, so as to avoid their tendency to dazzle drivers and pedestrians.

We might, in fact, assume that any source of light of great intrinsic brilliancy must be regarded as the crude product until it was effectively screened by the aid of a suitable diffusing shade; in America it had now become customary to supply "units" which consisted of a source of light equipped with a suitable reflector or globe.

Indeed, so serious was the effect on the eyes, of brilliant unscreened sources in the direct range of vision, now felt to be, that he would almost consider the time ripe for definite Governmental recommendations that such sources must invariably be provided with a suitable diffusing screen or shade, in order to adequately protect the eyes.

Shades and Reflectors.

The lecturer next turned to a few of the methods of reducing the intrinsic brilliancy of illuminants by suitable shading. He referred to the use of opalescent, opal, and frosted glass for this purpose, and spoke of the æsthetic value of silk shades in order to tone down the brightness of lamps in drawing rooms, &c.

Such methods served the purpose of producing a suitable diffusing surface; unfortunately, by so doing it was not easy to secure really adequate diffusion without at the same time losing an enormous amount of light. In addition such methods only served the purpose of reducing brightness; they were not effective in distributing the light in any desired direction.

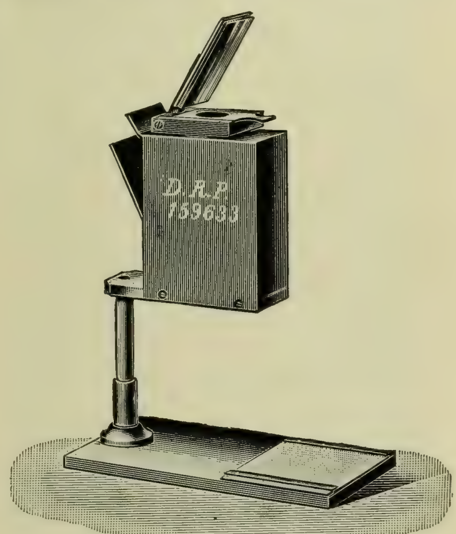


Fig. 3.—Thorner Illumination Tester.

Many cut glass globes used until recently utilized grooves in the glass only in a haphazard manner, with the result that, although a certain amount of diffusion was obtained, there was no serious attempt at concentration or distribution.

About twenty years ago, however, some experiments were made by Mr. A. P. Trotter in this country, and M. Blondel and M. Psaroudaki in Paris, with the object of making scientific prismatic glassware, termed by them "Holophane," which should not only absorb a minimum amount of light, but should diffuse it, and also distribute it in any direction desired in a scientific manner.

More recently in 1897, the Franklin Institute in Pennsylvania awarded the John Scott Legacy Medal and Premium to Messrs Blondel and Psaroudaki, for their invention of a Holophane globe which secured much better diffusion and more satisfactory distribution than any other globe known to its members.

To the Holophane Co. was due the credit of having taken up the question with great energy in the United States and Europe, and for many years they had manufactured fixtures of this kind for use with gas, electricity, or any other illuminant, and designed specially with the object of throwing the light in any desired direction. A number of Holophane globes and reflectors were on exhibition.

Fig. 4.—Holophane Reflector.

These glass reflectors were of special interest, because they were so designed that, while concentrating the great bulk of the light in a downward direction, where it was wanted, they also allowed a small amount to pass in an upward direction; therefore a suitable silk shade could be mounted over such a reflector thus securing the advantages of efficient reflection, and yet allowing enough light coming upwards to make the shade appear ornamental. Metal and other kinds of reflectors might serve to concentrate the light to some extent, but had not this quality.

Inverted Lighting.

Mention might next be made of the inverted system of lighting by means of which all the rays of a source were thrown on the ceiling, and the eye therefore received no direct rays; an approximately shadowless illumination might thus be obtained. The coming of the high candle-power efficient metallic filament glow lamp might lead to the more general adoption of this method; the inverted fixtures shown in the illustrations on the opposite page are examples.

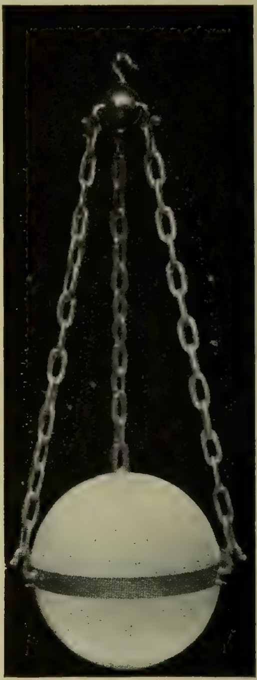
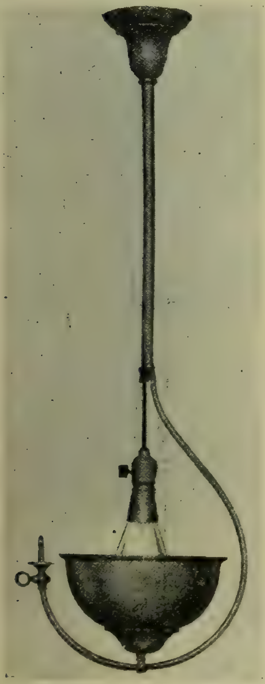


Fig. 5.—Holophane Diffusing Globe.

At one time the production of an entirely shadowless illumination was held to be very desirable, as it seemed to bear a close resemblance to daylight conditions. More recently, however, illuminating engineers had

FIG. 6a.—Illumination of a Room (12×14) by means of 60 Watt Inverted Unit.



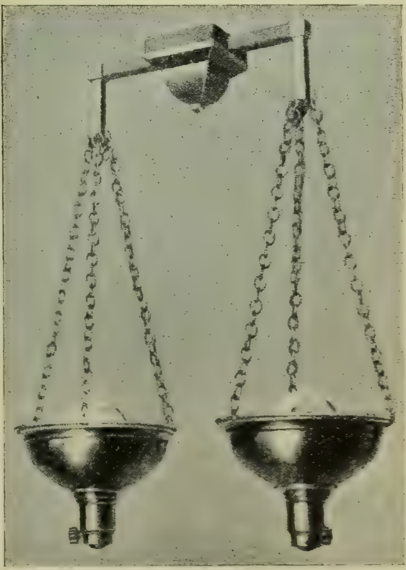


FIG. 6b.—Combination Gas and Electric Fixture. FIG. 6c.—Two-Unit Fixture.

TUNGSTEN INVERTED LIGHTING.

(A. D. Curtis and A. J. Morgan, *Trans. Illum. Eng. Soc.*, Dec., 1908.)

come to feel that an intermediate condition of things was often desirable. We usually did not want very sharp contrasts of light and shade, which were admittedly trying to the eye, but, on the other hand, artistic and even utilitarian requirements rarely favoured entire lack of shadow.

were very different. There was at our disposal a bewildering choice of illuminants, many of them competing very closely in certain fields and we needed every method available of discriminating between their respective values. People now realized that the fundamental use of a source of light

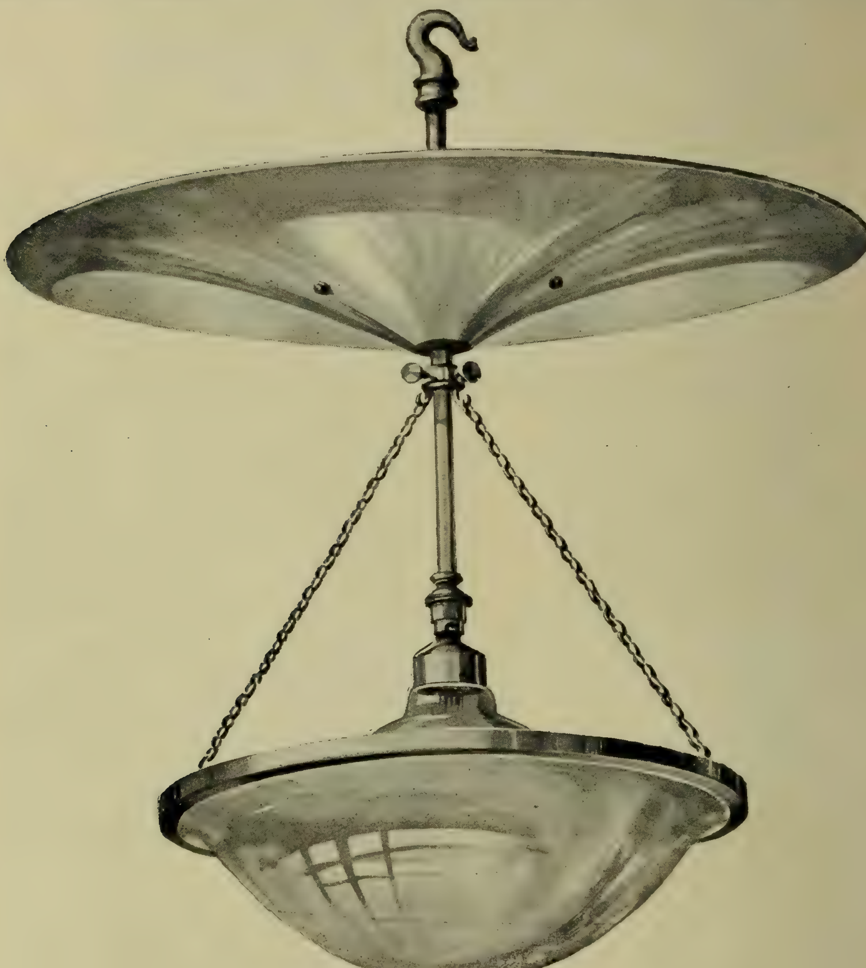


FIG. 6.—Tungsten Inverted Unit.

PHOTOMETRY.

The lecturer next dealt briefly with the value of photometry and the measurement of light and illumination. At one time photometry was regarded merely as an interesting and perplexing scientific playground, and its vital application to practical problems was hardly generally realized. To-day matters was to *illuminate*, and therefore it was obviously essential to systematize our methods of comparing the relative illuminating powers of different lamps; photometry, therefore, had become a science and art of industrial importance.

There had of late been a large number of ingenious types of photometers brought forward, so that to-day

Fig. 7.—Diffused Lighting by "Regina" Arc-Lamps.

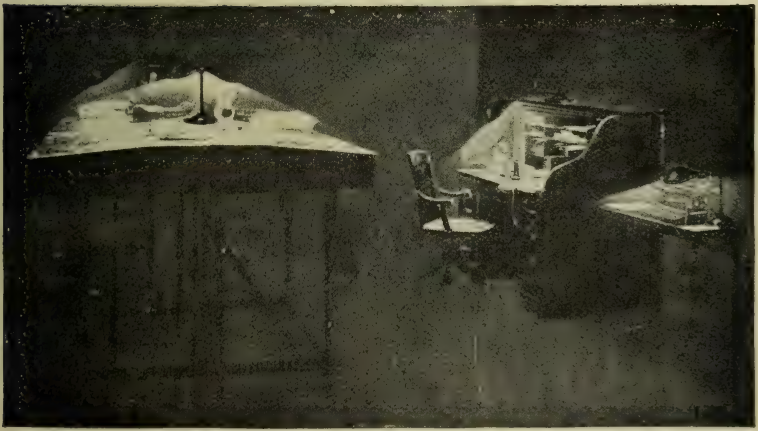


Fig. 8.—Local Desk Lighting with Sharp Contrast.

we had a choice of a number of excellent instruments, where a few years ago, there were, perhaps, only two or three that were generally known. But perhaps the most striking development in principle had been the introduction of instruments intended to measure, not the illuminating power of sources, but the actual illumination available in the street or at the table at which we were seated &c.

In this connexion it was very interesting to recall that Sir William Preece, in a paper before the Royal Society in 1883, had laid stress on this very point. (See *The Illuminating Engineer*, vol. ii., February, 1909, p. 135).

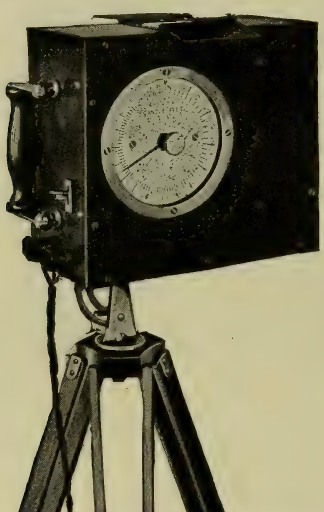


FIG. 9.—The Trotter Universal Photometer.

Moved by these considerations Sir William Preece and Mr. A. P. Trotter were among the very earliest in this country to devise "Illumination-Photometers," or, as they are now sometimes called, "Illuminometers." Quite recently the development of an interest in illumination had led many to realize the practical importance of such instruments, and types had been designed in England by Mr. H. T. Harrison, Messrs. Everett Edgcumbe & Co., and Messrs. Alexander Wright, and others. In addition a very large number of these instruments have been brought forward in Germany (such as the Martens instrument of Messrs. Franz. Schmidt & Haensch) and the United States, and some of them formed the subject of an interesting paper by Mr. Preston Millar at the first Annual Convention of the Illuminating Engineering Society in 1907. It was impossible in this lecture to deal with these instruments in detail, but we might refer to an article, dealing with some of them, in the first volume of *The Illuminating Engineer* (vol. i. June, 1908, p. 498). What he wished to emphasize, however, was that there were now available actual instruments for the measurement of *illumination* as

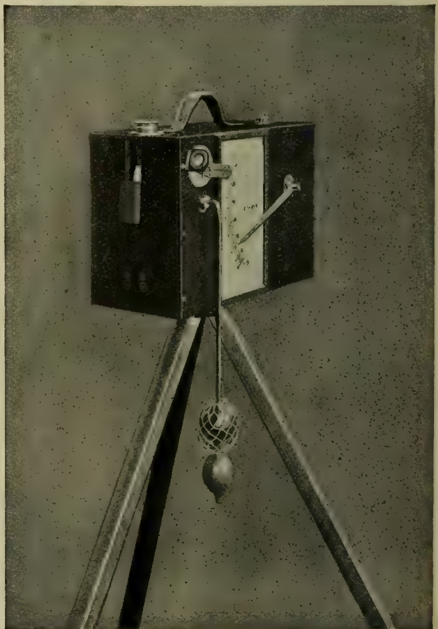


FIG. 10.—Harrison Street Photometer.

opposed to *light*, and that, therefore, we might hope in the future to be able to specify the amount of illumination required to read by or for any other purpose, just as a grocer supplied one pound of tea, neither more nor less—that was if he were an honest grocer. No doubt the increased demand for accuracy would lead to the development of yet more perfect and simpler instruments in the future.

And lastly, allusion might be made to the efforts now being put forth to establish measurements of light on a

definite international basis. Government laboratories had now been established in the chief countries of Europe, and in the United States, and a determined effort had been made to bring the units to a common basis, and to determine accurately the relations between the standards used in different countries. For this purpose carefully standardized glow lamps were now regularly exchanged and compared between the chief laboratories in England, France, Germany, and the United States.

The next step would be for all the nations to agree upon a common unit of light, and he was glad to say that considerable progress had been made in this direction, a fair share of the credit attaching to these efforts being due to the Illuminating Engineering Society in the United States, who had been working in harmony with the American Institution of Electrical Engineers and the American Gas Institute, for the furtherance of this end. Any such agreement, however, could be of little permanent value unless it satisfied not only representatives of different countries, but also representatives of the different systems of lighting in use in those countries. At the meeting of the International Electrotechnical Commission in this country last year, the lecturer had recommended that no definite steps should be taken until an opportunity was provided for the expression of the views of those representing not only electric lighting, but also gas and other systems. This had been borne in mind by the sub-committee dealing with the standard of light, who had adopted representatives of the gas industry.

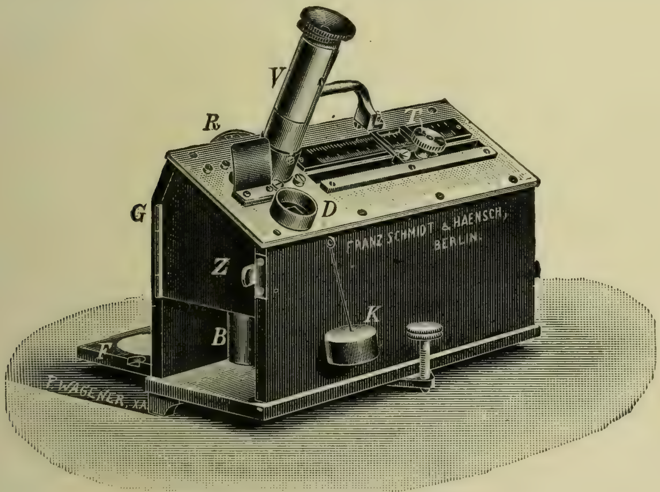


Fig. 11.—The Martens Illuminometer.

School Lighting.

The lecturer now turned to the subject of school lighting. No one would question the importance of lighting schools in which children were confined at a crucial period in their physiological development, in a thoroughly satisfactory manner. Here again the Society of Arts had done good work. Mr. Brudenell Carter, as far back as 1885, had contributed a paper to the *Journal* on the "Influence of Civilization on Eyesight," and again in 1898 on "The Eyesight of Children." Time did not enable him to quote the exhaustive data that had been accumulated to prove that the eyesight of children steadily deteriorated during school life, but he might refer to an article he had contributed to the *Journal* of the Royal Society of Arts in 1908, and to a special section in the first number of *The Illuminating Engineer*, January, 1908, in which this matter was exhaustively treated.

It was, indeed, generally admitted, as of course, it stood to reason it would be, that defective eyesight was at least partially due to bad lighting in the schoolroom. The light might be insufficient in quantity and so strain the eyes of the child attempting to read. It might also come from the wrong direction, and Mr. Brudenell Carter had shown how this might affect the attitude of a child seated at his desk, and indirectly affect his growth. The light striking the paper on which a person was writing ought to come from over the left-hand shoulder, so as to avoid the formatlon of shadows from the hand, such as might occur when the light was placed on the right.

The importance of this question to the nation would be understood from the fact that there were about 1,000,000 children in the schools of London alone. It was interesting to recall that Mr. Brudenell Carter, as far back as 1885, approached the School Board for London, and tried to induce them to organize periodical testing of the eyes of their children. That Dr. Carter had ample grounds for urging this improvement would be understood from the decisive nature of the results of the tests of the German Prof. Cohn, who in 1865 examined the eyes of about 10,000 school children and found that 1,630 of these had eyes of faulty shape; in addition, Mr. Adams Frost had examined a Board School in the South of London and found that 73 children out of 267, or rather more than one-fourth, suffered from defective vision.

On this occasion, as we had since had ample reason to regret, this recommendation was not complied with. At the present day our views were more enlightened, and only last year it was decided by the London County Council for the first time to undertake periodical tests of this description. But he felt constrained to point out that tests of eyesight alone were insufficient, unless accompanied by some study of the conditions of illumination; it was no use studying a disease without also taking account of the conditions by which it was produced. Dr. Kerr, the Medical Officer of the London County Council, had studied the illumination in 163 schools and found that the artificial illumination of about 20 per cent was classed as only "fair," while 18 were considered "bad"; very similar figures were quoted for the daylight illumination. Now he felt that, when the appointed authority took this view, it was sufficient to justify his contention that the study of proper day and artificial illumination in schools was a matter that deserved very careful study indeed.

Factory and Barrack Lighting.

In factories and barracks, again, although dealing mainly with adults, instead of children, we had a case of large numbers of people constantly at work under more or less stereotyped conditions. He understood that the War Office were considering the desirability of adopting some definite plan of securing that the lighting of barracks was in conformity with modern requirements.

In the same way it would seem to be a truism to say that good illumination in factories was not only absolutely essential to the work people, but expedient from the point of view of the employer. Good illumination, was not a luxury but a necessity, and therefore ought to be insisted upon every whit as keenly as the provision of adequate sanitation and ventilation, which, by the way, had only become the subject of Government inspection and recommendation and in extreme cases of prosecution, very recently.

Moreover, in the case of almost all skilled labour it was quite certain that the expense of bringing the lighting up to the requisite standard was but a trifle in comparison with the amount that would be saved by the improvement, both in quality and output of work.

Another point on which stress should be laid was that a very close connexion undoubtedly existed between the number of accidents that occurred in works, and the condition of the lighting. Naturally, it was easier for an employee to allow a limb to stray into machinery which in a dingy ill-lighted room, was blurred and indistinct, and accidents were more liable to happen under

these circumstances. If, however, the machines were properly illuminated a small defect would be recognized and detected at an early stage before anything serious occurred. In addition, the incorrect placing of light sources, and the resultant throwing of inconvenient shadows by tools, was just as likely to be responsible for an error of judgment on the part of an operator engaged in a delicate piece of work. At the present moment this matter is of particular interest, in view of the Commission that had recently been appointed to consider causes of accidents in factories and workshops, and he thought that no such inquiry could be considered complete that did not take into account the part played by defective illumination in causing accidents of this nature.

Some recommendations had recently been published on the Continent which showed that authorities were becoming alive to the importance, from the hygienic standpoint, of proper lighting in factories.

LIGHTING OF HOSPITALS, LIBRARIES, CHURCHES, &C.

Under this heading might be included a number of miscellaneous cases of lighting, all of which were of very great importance, but which, unfortunately, would require a lecture to themselves if treated fully.

It was, however, obviously necessary to light a hospital, where people in an invalid and depressed condition were confined, with special care. The correct lighting of libraries, too, was a vital matter, because the people who used libraries, in the evening by artificial light, were usually earnest students—the class of people for whom libraries were mainly intended.

Both libraries and hospitals frequently constituted an expense to the general public, who had a right to see that the best value was got for their money, and the lighting of a number of such public buildings might in the aggregate amount to a considerable sum; therefore it was only fair that care should be taken to secure efficient results, although exercising due economy. In this connexion he might mention the paper of Mr. L. B. Marks, who had recently undertaken and described the lighting of the Carnegie libraries in New York, in a specially careful manner (*Illuminating Engineer*, vol. 1, 1908, p. 921.) and he would like to point out the absurdity of paying for the collection of expensive books—sometimes unique and unreplaceable—housing them in costly buildings, and then providing a system of illumination that made reading them a weariness to the flesh. For naturally the eyes would suffer if a person was constantly engaged in working by bad artificial illumination.

Lastly, a few words might be said upon the lighting of CHURCHES and public buildings of architectural distinction. In such cases, economy and illuminating efficiency, in the technical sense, were often subservient to artistic effects. But once more it must be remembered that it was only through the eye, and through the illumination provided, whether daylight or artificial, that the interiors of such buildings were visible at all. Therefore it was surely desirable to scheme out the lighting very carefully, and to consider exactly what the sources used had not to do. This was a matter to be commended to the study of architects, who were now coming to take a keener interest in questions of illumination.

PHYSIOLOGICAL ACTION OF LIGHT.

Reference was next made to the interesting question of the physiological consequences of the difference in the colour of light yielded by modern sources. Sufficient evidence had not yet been accumulated to enable us to determine the effect of very peculiar coloured light in any quantity on the eye, though there was scientific work on record that was very suggestive. Therefore it seemed advisable to be cautious in working for long hours under any very peculiar variety of light. Prof. Burch had described disturbances of colour-vision which might be called into play through intense stimulation of the eye by monochromatic light, and it was legitimate to suggest that prolonged working under light of one colour might eventually affect the eyes in some such way.

It was pointed out in the last lecture that the distribution of energy in the spectrum of illuminants varied yet more greatly than their apparent colour. Very possibly different qualities of *invisible* light might be found to yield different physiological effects.

The Effect of Ultra-violet Light on the Eye.

This led to a very interesting question that had recently been the subject of much discussion, namely, the effect of the invisible rays of very short wave length beyond the violet in the spectrum of artificial illuminants. As the temperature of an incandescent solid body increased, the maximum of the curve of radiation was shifted forward towards the blue in the spectrum, so that the percentage of ultra-violet energy was distinctly increased. These rays were known to exert very marked physiological and chemical actions, and it had therefore been the subject of consideration how far the tendency towards accentuating them might be injurious.

Apart from this tendency on the part of incandescent solid substances we had now at our disposal certain sources such as the quartz tube mercury vapour lamp, which were particularly rich in such radiation, and were, therefore, claimed to be specially serviceable for particular uses, such as the destruction of bacteria, the treatment of leather, and for photographic and medical purposes. For instance, certain types of long enclosed arclamps, such as the "Regina," were claimed to be specially adapted for photographic purposes. One of these lamps was exhibited by the kindness of Messrs. Marples, Leach & Co.

The percentage of ultra-violet energy in ordinary incandescent illuminating agents was known to be very small—On the other hand, it had been estimated that as much as 30 per cent of the total energy radiated from the mercury quartz tube lamp was available in this form. Naturally, therefore, it was desirable to take special precautions in the case of such sources which might have an injurious action on the eyes of any one using them.

How effectual a small change in the quality of radiation might be in causing the eyes inconvenience was shown by the experiences of travellers in the snowy regions and at high altitudes, where the atmosphere was not sufficiently dense to absorb the ultra-violet rays in daylight as it did on the horizon. Snow blindness, and the tanning of the skin were well known symptoms attributed to such conditions.

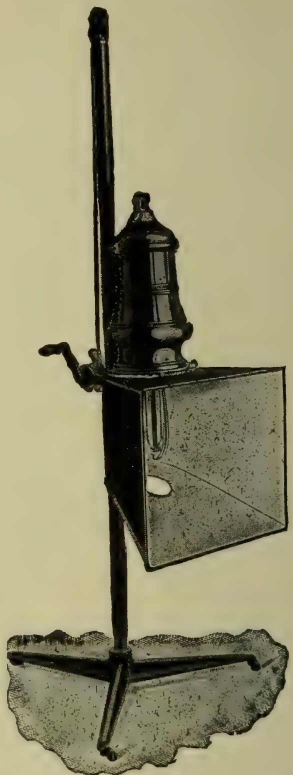


Fig. 12.
Enclosed Arc-Lamp for Therapeutic Work.

A considerable amount of work had been done on this subject by Drs. Schanz and Stockhausen in Germany. These observers had contended that artificial light was invariably more wearisome to the eye than daylight, and disapproved of the tendency towards accentuating the ultra-violet, as represented by some of the latest developments in modern artificial sources of light. Widmarck and other workers, it was said, had found that by concentrating ultra-violet light on the eye lens a

turbidity was set up, and that the lens subsequently became semi - opaque. It had even been suggested that cataract was at least partially due to the action of these rays, and the well known predominence of this defect among glass workers had been ascribed to the rays given out by the glowing material; this question formed the subject of investigation of a special commission appointed for the purpose.

Drs. Schanz and Stockhausen had studied the effect of different varieties of ultra-violet light, dividing them into three classes, as shown bv the adjacent table.

These observers also contended that ordinary glass, which absorbed the rays from 0·3 μ onwards, allowed those between 0·4 μ and this value to be transmitted unchecked. They had, therefore, devised a special variety of glass termed "Euphos" for the purpose of absorbing these injurious rays, some samples of which, including specimens of chimneys and electric lamp bulbs made of the glass, he was able to exhibit, by the kindness of the inventors. Glasses in several grades of opacity were shown.

For this glass the authors claimed that although the ultra-violet radiation was so effectively absorbed only 2 or 3 per cent of the visible radiation was lost.

Mr. Gaster then performed a few experiments illustrating the nature of the ultra-violet rays, and the properties of the Euphos glass. The spectrum of an arc light was thrown upon a screen made of Barium platino-cyanide and it was pointed out how the region of invisible energy beyond the violet caused fluorescence of a vivid green. These rays only became visible by the aid of some such fluorescent material. A bit of blue Uviol glass was then inserted and had the effect of stopping nearly all but the violet and ultra-violet rays. The Barium platino-cyanide screen and a block of Uranium glass became vividly fluorescent when placed in the beam of light. It was then shown that the Euphos glass, which scarcely affected the visible spectrum, was almost opaque to ultra-violet energy, and caused a well marked shadow on the fluorescent screen when interposed between this and the source of light; chimneys and lamp bulbs composed of this glass had the same effect.

In conclusion, Mr. Gaster said that he did not wish to over-emphasize the importance of the physiological action of these rays. He had dwelt upon the subject because it was typical of many problems that would crop up in the near future, and could only be solved by co-operation between the physicists and physiologists. For this reason, whatever opinion we might hold as to the validity of the conclusions of Drs. Schanz and Stockhausen, their researches were well worthy of imitation.

TABLE II.

Action of Ultra-Violet Light upon the Eye.

I.	II.	III.	IV.
760–400 $\mu\mu$.	400–350 $\mu\mu$.	350–300 $\mu\mu$.	300–0 $\mu\mu$.
Visible Rays. Reach the retina unaltered in character.	Ultra-Violet Rays. Cause the lens to fluoresce a lavender-grey, reach the retina, and are visible if the lens is removed, or if the visible region of the spectrum is suppressed.	Ultra-Violet Rays. Penetrate the eye, but do not reach the retina. Also absorbed by the eye-lens.	Ultra-Violet Rays. Do not penetrate, but cause inflamation of the outer eye.

He might mention that the matter formed the subject of a very animated discussion before the German Institution of Electrical Engineers last year, at their annual meeting. Coming from a purely technical body this was an important recognition. It had also been the subject of consideration by the *Versammlung der Opthalmologischen Gesellschaft*, at Heidelberg. On the other hand, it was only fair to state that the matter was not yet ripe for definite decision, and that there were many, among whom he might make special mention of Dr. W. Voege of Hamburg, who differed from the conclusions of the authors referred to.

Concluding Remarks.

In conclusion, Mr. Gaster said that if he had done nothing else in these lectures, he hoped he had succeeded in giving an idea of the vastness of the subject, and of the need for a specialist who could take an impartial view of all illuminants, and who could sympathize with the many different points of view from which problems in illuminating engineering had to be studied. In his paper before this Society three years ago he had insisted upon the necessity for the expert illuminating engineer, though he had then hardly anticipated such immense strides in the progress of different illuminants and in the subject of illumination. Naturally, such an expert could only be gradually evolved.

In order that the subject might be studied in a satisfactory manner, a society providing an impartial platform was necessary, and the experience of the Illuminating Engineering Society in the United States should serve to indicate the field which lay before a gathering of this description. On February 9th of this year it was decided to proceed with the creation of a similar Society in this country, and he hoped that its aims would meet with the sympathy of those present.

Mr. Gaster then concluded with a few words of thanks to those who had assisted in connexion with these lectures, making special acknowledgment of the liberal manner in which those connected with different systems had come forward and exhibited on such a generous scale. He thought that their efforts in this direction should serve as an object lesson to those people who had contended that it was impossible for one man to gain the sympathy of those interested in all the different methods of illumination. Although interested in the different illuminants he had, until recently, been mainly concerned with electrical work, but he had found it to his advantage to follow up the details of all methods of illumination in order to be able to advise others impartially. He thought it would be admitted that in these lectures he had at least sought to preserve an impartial attitude. That the subject of illumination was now regarded as a matter of common interest, was, he thought, proved by the unique collection of different systems of lighting that he had been able to exhibit, and the close attention with which these lectures had been followed by such a distinguished audience—an interest which he very much appreciated.

And next he wished to express his great indebtedness to the Royal Society of Arts for granting such exceptional facilities in order to render the exhibition of these systems of lighting possible. He had been allowed to introduce inflammable substances into the lecture theatre, to run piping and to put them to no little inconvenience by the constant stream of those at work in erecting the exhibits. This might be taken as an indication that, with due precaution, all these systems could be regarded as safe for interior lighting, and that there was room for the application of them all. The Society had been exceptionally kind in placing their staff at his disposal, and he wished to express his indebtedness to the constant and unremitting efforts of Mr. Davenport, who had devoted much time to these lectures and assisted throughout to an extent that few who did not know the preliminary work that such lectures entailed, would adequately appreciate.

And lastly, he felt it his duty to thank those who had assisted him in preparing the material and experiments for these lectures, and for the trouble they had taken on his behalf. Special

thanks were due to Prof. Stirling, for the instructive series of slides and diagrams illustrating the eye, which he had kindly sent from Manchester University, and also to Prof. J. T. Morris and Dr. C. V. Drysdale, who had assisted in the same way. He wished, in particular, to express his appreciation of the services of his assistant, Mr. J. S. Dow.

FOURTH LECTURE, March 8th, 1909.

Thanks are due to the following firms who have kindly exhibited at this lecture.

The Bryant Trading Syndicate, Ltd.—Transformer for experimental purposes.

The Chloride Electrical Storage Co., Ltd.—Loan of a small battery of accumulators to supply current to Bechstein Flicker Photometer.

Messrs. Everett, Edgcumbe & Co., Ltd.—Example of Trotter Universal Photometer and Portable 'Watt-Photometer.'

Messrs. Elliott Bros.—Example of Harrison Universal Photometer, adapted to measurements in a horizontal plane.

Messrs. Franz, Schmidt & Haensch (Berlin).—Marten's Illumination photometer, Thorner illumination tester, Bechstein flicker photometer (electrically driven), Bechstein constrast photometer.

The Gas Light and Coke Co. (Mr. F. W. Goodenough).—Series of incandescent gas lights equipped with various types of burners and shades for interior lighting.

The General Electric Co., Ltd.—Large type of multiple high candle-power metallic filament lamp fixture and single high candle-power osram lamp fitting.

The Holophane Glass Co.—Examples of types of holophane shades, shades and reflectors for use with gas and electric light fittings.

Messrs. Marples, Leach & Co,. Ltd.—Regina Special arclamp for photographic purposes.

Messrs. Millar & Weltch (Boston, U.S.A.).—The Williams 'Simplex' Photometer.

Messrs. Gebr. Putzler (Penzig, Schles., Germany).—Specimen sheets of 'Euphos' glass opaque to ultra-violet light, in four grades of opacity; examples of chimneys and glowlamp bulbs composed of Euphos glass.

Messrs. Julius Sax & Co., Ltd.—Electric fittings and glassware for artistic decorative indoor illumination.

Messrs. W. Watson & Sons.—Fluorescent Barium platino-cyanide screen; samples of 'Uviol' and 'Uranium' glass; specimens of Jena flint glass opaque and transparent to ultra-violet rays respectively.

Special thanks are also due to **Drs. K. Stockhausen** and **F. Schanz, of Dresden,** the inventors of the "Euphos" glass, who kindly arranged for the exhibit of the specimens mentioned above, and also sent a series of lantern slides illustrating their properties; also to **Prof. Stirling, Prof. J. T. Morris,** and **Dr. C. Y. Drysdale,** for the loan of lantern slides.

Acknowledgment must also be made of the courtesy of the **City and Guilds of London Central Technical College** for kindly sanctioning the loan of some apparatus, including a photometrical bench, specimens of Uranium glass, &c.

Annual Meeting of the Verband Deutscher Elektrotechniker.

The annual meeting of this society is to take place on June 2nd to June 5th, at Köln a. Rh., Germany.

Among the papers to be presented on this occasion we note that of Mr. Libesney, of Berlin, entitled 'Die weitere Entwicklung der Metallfadenlampen auf Grund der Erfahrungen des letzten Jahres' and Prof. Dr. Bermbach on 'Eine Universalbogenlampe mit parallelen Kohlen selbstregelnd, ohne Regelwerk.'

Some Notes on the Early Development of Gas-Lighting in London.

By an Engineering Correspondent.

The first application of gas to lighting in London took place about 1807. Previously, Dr. Clayton, in 1735, Dr. Hales, the Bishop of Llandaff, and Lord Dundonald in 1781, had experimented in connexion with the manufacture of illuminating gas from coal; but it is to Murdoch, who in 1798 illuminated his factory at Soho by this method, that the credit of having first brought the discovery to a practical stage belongs.

It was, however, mainly the perseverance of the German Winsor that led to the illumination of the streets of London by this means. His first experiments were made at the Lyceum, in the Strand, in 1803, and he afterwards lighted the Carlton Palace gardens.

In this connexion, Walker in his 'Original' remarks :—

"The first exhibition of gas was made by Winsor, in a row of lamps in front of the colonnade before Carlton House, then standing on the lower part of Waterloo Place; and I remember hearing Winsor's plan of lighting the metropolis laughed to scorn by a company of very scientific men."

There were many ignorant persons who strenuously opposed the introduction of gas in London, but even the great Sir Humphrey Davy is credited with the remark that it would be as easy to bring down a bit of the moon to light London by as to do so by gas. Yet the whole of Pall Mall, from St. James's to Cockspur Street was so lighted in 1807, gas having replaced the old oil-fed lamps with cotton wicks.

Mainly in order to demonstrate the practicability of the process before Parliament, and in the eyes of the general public, Winsor caused to be circulated a number of pamphlets, in which the merits of the new means of lighting were set forth. The following is an extract from one of these now memorable documents :—

"The plan of the intended Light and Heat Company professes to increase the wealth of the nation, by adding to the number of its internal resources; and on this ground it is entitled at least to a candid examination. The object of the following pages is to rescue it by a fair, and not overcharged statement of its merits, to appeal from prejudice and ignorance to the good sense of the community. The facts and principles on which it is founded have been made to turn them to account. If a strong case be made out, the promoters of the plan are justified in expecting the support of Parliament and of the public."

Winsor eventually succeeded in raising £50,000 by subscription, to be invested in a company for the object of promoting his schemes, and an application was made to Parliament for a suitable Charter in 1808. Much correspondence passed between Winsor and Mr. Perceval, then Chancellor of the Exchequer, who, however, declined to give his support to the measure, alleging "the advanced state of the session which did not allow a private bill to be introduced," but being in all probability influenced by doubt as to the practical utility of the project, and apprehensive of the opposition with which it would have to contend. Among those who bitterly opposed the idea may be mentioned the dealers in oil and tallow, who drew dismal pictures of the ruin that would follow the encouragement of the new method.

At last, however, the Government, recognizing that the use of the new illuminant would reduce the considerable expense to which they were put in

connexion with public lighting, thought fit to sanction the new undertaking, which, it was also urged, would provide employment for many hands and would be a profitable investment for British capital. In August, 1807, the new illuminant was employed to light Beech Street. Whitecross Street, and the Golden Lane Brewery. The use of gas continued to extend, though Winsor's expectations of enormous profits were not realized. Indeed, the subscribers to his company, who had been promised so much,* never had a penny of their money returned to them.

Before he died, however (in 1830), he had the satisfaction of seeing his method firmly established in London.

The business of the first chartered company was also for a long time unprofitable, but in 1822–3 they had largely overcome their early difficulties. It was shown in 1823, upon a Parliamentary investigation into the affairs of the chartered company, that they produced 680,000 cubic feet of gas every night, giving a light equal to 30,000 pounds of tallow candles. London was at that time supplied with 39,504 public gas lamps, furnished by three principal companies, the length of gas-lit streets extending to 215 miles. In 1830—the year when Winsor died—the City Gas Company alone maintained about 8,000 lamps, and its mains extended 50 miles.

* Winsor guaranteed to his subscribers an "absolute certainty" of £600 for every £5 invested, and anticipated an annual profit of £115,000,000 !

The history of the early development of gas-lighting, therefore, should serve to indicate how a new movement must often expect opposition at the hands of vested interests, and how immense early difficulties may be ultimately surmounted.

These difficulties which, at the inception of a movement, appear to many people so insuperable, may eventually disappear so completely that another generation finds it hard to credit their original existence.

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The County Council and the Gas Light and Coke Company's Bill.

A CALORIFIC POWER TEST AGREED UPON. (From *The Gas World.*

AT a recent meeting of the London County Council the Parliamentary Committee reported that they had agreed with the Gas Light and Coke Company to withdraw their opposition to the Company's Bill, on the understanding that the standard price of gas should be reduced from 3*s.* 3*d.* to 3*s.* 2*d.*, and that a standard of calorific power of 125 calories net be established, the tests being taken on an average of three days, and subject to a margin of 10 per cent being allowed before any penalty is incurred, the whole arrangement being subject to revision by the Board of Trade, on the request of the Council or the Company, at the end of every three years. In addition, the Company agreed to meet the Council as to fixing burners, free of charge, suitable for the consumption of gas of 14 candle-power, and the charging by the Company of the same price south of the Thames as that charged by the South Metropolitan Gas Company for 14 candle-power gas, in accordance with the amalgamation scheme of 1883. The Company further agreed that the price for public lighting in the whole of their area should be the same as the lowest selling price to any consumer. The Committee regarded it as a distinct advance that the Council had been able, *for the first time, to obtain the insertion in an Act of Parliament of a standard of calorific power,* and this was of the utmost importance, having regard to the extent to which gas was now used for cooking and heating purposes. The report was adopted.

The Lighting of Large Outdoor Areas.

By an Engineering Correspondent.

An exceedingly interesting piece of outdoor illumination was described in a recent number of *The Electrical World* of New York, namely, the lighting of the arena, 450 ft. × 227 ft. in area, at the Military Tournament and live stock show at St. Joseph, Mo., U.S.A.

In this case the illumination was carried out by 127 six-amp. multiple alternating current arc-lamps, on 110 volts, which were slung on stretched wires in the manner shown in the illustration. The watts per square foot amounted to about 0·52 (assuming a power factor for the lamps of 62 per cent), and it is also stated that the illumination was sufficiently bright to enable faces to be distinguished right across the arena, and compared very favourably with indoor lighting.

Lighting of the Parade Ground at the Military Tournament at St. Joseph, Mo., U.S.A.

The possibilities of expending light in this way, by massed units slung on wires in such a way as not to obstruct the movements of those below, are interesting. Provided the cost could be kept within reasonable limits, the method might be of possible application to athletic grounds, for instance. During the winter practically the only time available to the majority of people of occupation for playing outdoor games is on Saturday afternoon, and even under these circumstances the light not infrequently becomes very bad before the game is finished in mid-winter.

Practically the only obstacle to the organization of games during the evening, when most people are at liberty, is the *absence of light*, and if it could be shown that the lighting of football and hockey grounds, &c., could be carried out on such a plan as the above at reasonable cost, it might open out a new future for athletics in large towns.

When a large "gate" may be expected, the question of playing matches by artificial light becomes one worthy of consideration, and it is stated that a league match between two well-known clubs recently took place under these conditions.

The Artificial Illumination of Factories and Workshops.

(Extract from the Proceedings of the Conseil d'Hygiene de la Seine, Nov. 8, 1907, p. 637.) Communicated by Our Paris Correspondent.

THE following is a translation of the report by MM. Chantemesse and Walckenaer on the lighting of factories in which artificial illumination is frequently employed, to which reference was made in our last number, and which was abstracted in a recent issue of our contemporary *The Revue des Eclairages*.

The Commission on Public Health in the third district of Paris drew attention in March, 1904, to the inconveniences involved in the constant employment of artificial means of illumination in factories.

This matter was brought to the notice of the Minister of Commerce and Industry, who replied, in a communication dated April 22nd, 1904, that this question was one of a number with which his department was occupied, and that he would be glad to take note of any recommendations of the Conseil d'Hygiene on the matter.

The regulations dating from March 10th, 1894, at that time in force, contained the following remarks under Article No. 5 :—

"Confined workshops in which employees are constantly at work must not be crowded ; the cubic capacity per workman must not be less than 6 cubic metres, and the premises must be adequately ventilated. These premises, especially passages and staircases, must be suitably illuminated."

Subsequently, this recommendation was replaced by that dating from Nov. 29th, 1904, which stated generally the conditions regarding the health and safety of employees in the case of works prescribed in the law of July 11th, 1903. In the new regulations, Article No. 5 is stricter and more complete than the corresponding recommendations of 1894. The cubic capacity per person employed is increased to 7 cubic metres for the ordinary premises concerned, and to 10 cubic metres in the case of laboratories, kitchens, shops, offices, &c., which are open to the public.

It is also directed that :—

"Confined working premises must be abundantly ventilated, and in winter suitably warmed. They must be provided with windows or other adjustable apertures in direct communication with the outside air ; the ventilation must be sufficient to prevent any marked increase in temperature. The premises must be suitably illuminated."

The question then arose as to whether the existing regulations were sufficient, and whether the Conseil d'Hygiene should recommend further amendment.

The use of artificial light leads to two sources of inconvenience to the worker. The light fatigues the vision, and in addition, works in which artificial light is employed leave something to be desired from the hygienic standpoint in other respects. Let us consider these two questions.

From the point of view of convenience to eyesight no conditions equal those existing when the work is carried out by proper daylight illumination. Close to a window from which a large sky area is visible, the average illumination on an ordinary day, leaving out of account the direct rays of the sun, may amount to 40 or 50 lux.* This order of illumination is that which general considerations suggest is desirable for the ordinary classes of work.

The artificial illumination provided may vary in intensity, in quality, and in the method of distribution. As regards intensity, it may be suggested that in favourable circumstances good

* By "lux" is understood the illumination corresponding to normal incidence, and caused by the rays from a source of intensity 1 bougie-decimale, *i.e.*, 1/20 of the Violle standard, at a distance of 1 metre.

conditions are represented by an illumination of the order of 15 lux, even in the case of works devoted to sewing or printing. In a spinning factory a value of 5 lux may be suggested.

In addition the quality of the light available varies very greatly, according to the degree of incandescence* of the sources employed.

In the case of an artificial source of light of specified intensity,† a high percentage of the less refrangible rays from the yellow onward promotes visual acuity, but adds little to the integral brightness of the source. On the other hand, a high percentage of radiation in the blue and violet regions of the spectrum causes illuminated objects to appear brighter and enables colours to be distinguished better, but these highly refrangible rays do not greatly contribute towards the assistance of acuteness of vision.

Finally there is the question of the distribution of light in the workshop to be considered. If the sources of light are directly visible, this fact tends to fatigue of the eyes owing to the accidental production of bright retinal images. Even if these sources are not directly gazed at, the mere fact that they are within the range of vision causes the pupil to contract, with the result that the general surroundings appear to the eye as if less brightly illuminated than they actually are.

Then, whenever the illumination seems insufficient, the workman is compelled to bring his eyes near to the work, and the tendency to visual fatigue following near accommodation is intensified. Fatigue of this nature is liable to lead to progressive myopia; in the case of long-sighted people it is particularly liable to cause headache and other troubles. We have not troubled to consider the corresponding case in which the actual or relative illumination of the workshop is high enough to be inconvenient, this being a state of affairs which is not met with under ordinary practical conditions.

This question of the effect of illumination upon the organs of sight is important, especially in the case of those whose eyes are very sensitive. But habitually working under artificial illumination is apt to lead to other grave troubles. In workshops so lighted the general hygienic conditions are usually more or less unsatisfactory. In cases in which natural illumination is employed by day, and we only have recourse to artificial lighting by night, the premises will probably not become unhealthy in themselves, but yet habitual working in the night-time is open to well-known objections from the hygienic and social point of view. But the existence of workshops which are illuminated solely by artificial means is yet more to be deplored. The danger of insanitary and unhealthy conditions arising in circumstances in which the microbe-destroying action of the sun's rays is not available need hardly be insisted upon. Such conditions are known to be particularly favourable to the development and propagation of tuberculosis

Premises which are used continuously at all hours, and from which the sunlight is always excluded, are also liable to suffer as regards ventilation. Such vitiation of the air is the more to be feared, because, except in the case of electricity, the illuminants themselves help to use up the available air and add their products of combustion to an atmosphere which already suffers from the respiratory products of the inmates.

The evil of artificial lighting is partially limited by the fact that it is expensive. Moreover, work is never so well or so rapidly done by the aid of lamps as by daylight. It is certain, therefore, that manufacturers only have recourse to artificial light when they are compelled to. The State is hardly in a position to forbid the carrying out

* The "degree of incandescence" of a source may be expressed in terms of the values of intensity obtained when first the rays are passed through a solution, which only allows rays of a wavelength of $0{\cdot}582\mu$ to pass, and secondly, through a red glass only allowing rays in the neighbourhood of $0{\cdot}657\mu$ to be transmitted.

† The intensities of two sources of light, which differ in composition, cannot be rigidly compared with and expressed in terms of a standard from which they differ. An estimate of their relative intensities can be made, however, by comparing that in the neighbourhood of $0{\cdot}582\mu$, which can be accomplished by causing the rays to be transmitted through an appropriate solution or coloured glass.

of work under these circumstances, but even if working by night be regarded as inevitable, however, special reservations may be made in the case of women and children.

Rooms from which the rays of the sun are always excluded are usually of a very special nature, such as vaults for the storage of wine or beer, refrigeratory apartments, &c.; there are also workshops in the basements or at the back of buildings, chiefly situated in the centre of Paris. Premises of the first class are not very numerous. As regards the underground or back workshops referred to, it may be pointed out that land in the centre of Paris is so dear, and the demands of business so exacting in this region, that it would be impossible to forbid their use altogether without greatly injuring a considerable number of important vested interests. All that can be done at the present time is to insist upon such premises being as well ventilated and lighted as possible. The severity of regulations affecting the lighting and general conditions prevalent in such workshops would in itself tend to discourage their too rapid growth, and would possibly reduce the number already in existence.

Before concluding it may be well to throw a glance over the legislation in other countries affecting this matter.

In Belgium the wording of the royal decree of March 30th, 1905, relating to the health and safety of workers in industrial undertakings, as specified in the law of Dec. 24th, 1903, is as follows :—

"Art. 6. Workrooms shall be suitably illuminated. During the day they must receive adequate daylight illumination. In all cases artificial illumination is admissible, if, owing to the position of neighbouring buildings or on account of other industrial conditions, the rooms do not receive the degree of illumination which the work carried out demands."

In addition these regulations contain the following specifications regarding artificial illumination :—

"Art. 7. The artificial lighting shall provide a constant and sufficient degree of illumination. Suitable measures must be taken to ensure that the means of illumination do not unduly heat or vitiate the air in the premises.

"Art. 9. Workmen must be protected against excessive radiation from the illuminating apparatus."

In Holland the royal decree of Jan. 31st, 1897, relating to the conditions of working of female and young employees under unhealthy or dangerous conditions does not allow the person protected to be employed on premises where, between 9 in the morning and 3 in the afternoon, artificial means have to be resorted to in order to secure sufficient illumination (save only in exceptional cases when the condition of the atmosphere renders artificial light essential). Moreover, the intensity of illumination must conform with certain definite requirements. In the case of the following trades — embroidery, working in precious stones, gold, and silver, engraving metals or wood, the manufacture of instruments, printing, mechanical knitting and quilting, sewing, draughtsmanship, the repairing of clocks and watches—an intensity of at least 15 bougie-metres is prescribed. In the case of other works requiring good lighting, an intensity of 10 bougie-metres is necessary.

In Austria the regulations of the Minister of Commerce, dated Nov. 23rd, 1905, and applying to industrial licensed premises, contains the following passage, under the title 'Natural and Artificial Illumination' :—

"12. The windows and skylights in workshops and factories must be so designed as to be adequately illuminated for the purposes of facilitating the work executed by the light they furnish. Measures must, however, be taken to secure that workers are not subjected to the direct rays of the sun in confined places.

"13. All factories....must be adequately lighted during the day."

In Germany, in the special case of printing works and factories for the casting of type, we observe, in the regulations prescribed in July 31st, 1897, the following remarks :—

"1. The floor of such factories must not be less than 1 metre below the ground-level. Exceptions may, how-

ever, be authorized by the authorities, provided special appropriate provision is made for hygienic ventilation and lighting....

"3. ....The rooms must be furnished with windows in sufficient number and of sufficient area in order to illuminate the premises satisfactorily...

"12. Illuminating apparatus capable of giving rise to production of a considerable amount of heat must be provided with means of protection in such a way as to avoid excessive heating of the workshop."

In Switzerland the regulations issued by the Federal Council in December 13th, 1897, contain the following directions as to the rebuilding of factories, &c.:—

"C. The windows shall be at least 1·80m. in height and their distance from the ceiling shall not exceed 30 centimetres.

"D. Workshops....must be provided throughout with satisfactory natural and artificial illumination."

In the Grand Duchy of Luxemburg the regulations are as follows (Grand Ducal Decree of March 11th, 1904, with reference to the security and health of workers in industrial factories and offices, Art. 6):—"Premises wherein work is carried out must be provided with suitable natural illumination by day and with proper artificial illumination by night. The artificial means of lighting must be such as to enable a suitable order of illumination to be secured."

In the United States the law bearing upon conditions of health in workshops and factories is merely stated as follows (Chap. 32 of General Laws, as amended by that of April 13th, 1904):—

"The Commissioner of Works shall, when he shall consider fit, issue directions prescribing the proper illumination of workshops."

Finally, we may quote the law of January 16th, 1904, in Western Australia, which is as follows:—

"The inspector may, at the desire of the authorities, or at the request of the occupant of a factory or workshop, &c., prescribe a minimum floor-area or cubic capacity of air-space required per individual employed....The space reserved in th waisy shall not be regarded as complying with the issued requirements unless adequately lighted and ventilated."

Compared with the various regulations on the part of foreign nations, the French regulations of November 29th, 1904, appear to fill an intermediate position in the scale of severity.

We will now report on the text of Article 5 therein, quoted at the commencement of this report. It is stated that confined premises in which work is carried out must be provided with windows or other adjustable openings communicating directly with the outside air. It is certain that it is in the interest of the proprietor to provide suitable window-space in order that the brightness of day may be available; if he has recourse to artificial means of lighting it is only because he cannot avoid doing so. In addition, it is directed that the ventilation shall be such as to prevent any marked increase in the temperature of the interior in which the work is carried out; in fact, workshops must be "adequately ventilated."

Without doubt this prescription is a little vague, but it is not possible to frame anything more definite without insisting upon too rigorous regulations, such as are not adapted to the flexible and variable modern industrial conditions, and would certainly be excessive in many cases.

The Administration can, therefore, only specify details in this matter by way of recommendation. In this way it may be suggested that walls of workshops should be painted a light colour so as to avoid absorption of light and facilitate diffusion.

In cases in which the illumination is furnished by one or more sources of light of high temperature (such as the electric arclight), it is desirable that the tint of the walls should verge upon the yellow, in order to reduce the proportion of highly refrangible rays in the light utilized. The direct rays from the arc should never be received by the eye; an excellent method of illumination is to project the light from the arc on to a white ceiling, at the same time screening it in a downward

direction; in this way the available illumination is provided by the light transmitted through the screen reinforced by that reflected from the ceiling. As a matter of general principle, sources of light, especially those of intense brilliancy, should invariably be placed outside the field of vision of the workers.

But however high the value of these recommendations is felt to be, it appears undesirable to give them the form of definite legal regulations. In this report it is only desired to express the entire approval of the Administration as to the regulations specified in Article 5 of the Regulations of November 29, 1904.

M. Chantemesse and C. Walckenaer.

Factory Lighting.

In connection with the above report some remarks in a recently issued bulletin of the Holophane Co. on the subject of factory lighting are well worth consideration.

We have often pointed out how the relatively small cost of making an installation satisfactory is often more than compensated for by the improved quality and output of the work turned out.

There are many people, however, who, while admitting the justice of this view, seem to think that it hardly applies to their own case, because they use artificial light for only two or three hours at most during the day—perhaps from four to six.

But it may be pointed out this period is, in many respects, the most important in the day. The men are often hurrying to finish up the day's work. They are probably tired; their senses are not so keen and their power of concentration is less perfect. In the publication referred to it is asserted that quite 75 per cent of the mistakes occurring in a factory take place after 4 P.M.; and accidents to operatives and machinery, and spoiled material may, in the year, amount to a considerable sum, which may be at least accentuated by bad lighting.

Again, it is suggested that the experience of most factory superintendents—that the men "taper off," and slacken towards night-time, is usually ascribed to physical exhaustion. May it, however, not be also due to their inability to see properly, and to the substitution of imperfect artificial illumination for the waning daylight?

One special cause of trouble, in addition to those enumerated in the report above, is the use of polished reflectors of a kind which give rise to streaks and shadows. In a factory the lamps are not infrequently in a continuous state of slight vibration, and the constantly moving streaks of light may be very trying to the eye. In a factory, therefore, and in any position in which the sources of light and their reflectors are apt to be set in vibration, an absence of such contrast, and a soft, even diffusion of light are very desirable.

The Representative Membership of the American Illuminating Engineering Society.

A recent canvass of the membership of the Illuminating Engineering Society showed that 56 per cent of the members are connected with the electrical part of the industry, 22 per cent with the gas part, the remaining 22 per cent being oculists, architects, &c. A large increase in the percentage of gas men is expected during the present year. Although the place and date of the next annual convention have not yet been selected it is probable that the convention will be held in New York City early in the autumn.—From *The Electrical World* of New York.

Beautiful Interiors and Appropriate Lighting Fixtures.

The illustration on the opposite page shows one of the main staircases of the Stockport Town Hall. It will be seen that the general effect is imposing; note, for instance, the ornamental wrought iron balustrade, for which Messrs. J. W. Singer & Sons of Frome, to whom we are indebted for the use of this block, are responsible.

Under these conditions, one would naturally suppose that the lighting fixtures installed ought to be on a correspondingly imposing scale, possibly massive in character, and certainly designed with a view to being ornamental and in keeping with their surroundings. In this case, however, it will be seen that the illumination of the corridor is provided by a single drop cord and shade, such as might be used in an ordinary office; it would be interesting to hear the views of some architects on this arrangement, as one would be inclined to suppose that many would prefer something of a more elaborate character.

No doubt one could cite very many instances in which a considerable amount of money is lavished on an interior, but the lighting fixtures do not receive correspondingly close attention, with the result that the general effect is not carried to its logical conclusion. Such matters would naturally seem to fall within the province of the architect whose scheme of decoration may be made or marred by the type of lighting fixtures employed in connexion with it.

In many cases the arrangement of the lighting of a building is considered last of all, when those responsible are impressed with the amount of money already spent on the general scheme of decoration; as a result the expenditure on lighting-fittings is cut down to a minimum. Seeing that the general appearance of an interior is so greatly influenced by the scheme of illumination adopted, this method of procedure must often constitute but short-sighted economy.

The Use of Dazzling Light in Aerial Warfare.

We gather from the reports of a recent lecture by Col. F. G. Stone before the Royal United Service Institution on March 10th, that the problem of locating and keeping air-ships illuminated by the aid of searchlights, owing to their extreme mobility, will be a difficult problem in the warfare of the future.

The abstract of this lecture given in *The Daily Express* (March 11th), suggests an extraordinary picture of a future battlefield, as seen by the lecturer :—

"Instead of solitary searchlights here and there, he said, there will have to be one skyward blaze of light from all over the area in danger. The aeronaut, blinded by the continuous glare, and himself visible to all the defenders below, will have to fly to the edge of the shining battlefield, there to be sought out by the single searchlight followed by shells from the guns below."

It seems, therefore, that the art of dazzling, so objectionable as involuntarily practised by some of those responsible for schemes of illumination by modern intensely bright sources, is yet not without a legitimate field of application.

View of Main Staircase of Stockport Town Hall.

Notes on Incandescent Gas Lighting.

By Dr. C. R. Böhm.

(*Continued from p.* 229.)

III.—The Artificial Silk Mantle

Lewes, in England, early stated his conviction of the superiority of the artificial silk mantle both to the ordinary cotton and ramie types. More recently Drehschmidt, in Germany, has constructed mantles of this kind, and found them to possess several noteworthy advantages.

There appear to be three distinct processes by which artificial silk mantles have been made up to the present time. The first method adopted by Knöfler (German Patent 88,556) seems to have been intended merely to circumvent the Auer patents, and consisted in the impregnating of the collodion solution with incandescing salts previous to the squirting of the thread. The method, however, proved to have practical difficulties, and was modified according to a subsequent patent (*G.P. 129,013).

The process described in the German patent No. 141,244 was the first to enable artificial silk mantles to be made in an industrial manner. According to this method the web of artificial silk was impregnated with the illuminating material in the usual way, and this was converted from nitrate to hydroxide by being drawn through an ammoniacal solution. Recently, researches have been made with the object of replacing ammonia by some organic base, but the use of the latter seems to give rise to complications. There is also no doubt that some portion of the incandescing material is lost in the process.

Patent No. 199,615, of Sépulchre & Co., which would seem to involve an attempt to avoid the Plaissetty patents, refers to the weaving of the artificial thread into mantles, in addition to the preparation of the actual fibre. The impregnated fibres are dried somewhat rapidly. As a result the effect of the ammoniacal vapour is limited to a relatively small time, the essential object being to convert only a portion—preferably the half—of the nitrate into hydroxide. The thread is then exposed to the air for several minutes and subsequently washed with distilled water, in order to remove all traces of ammonium nitrate. After being dried the thread is knitted into the mantle-fabric. In a second portion of the specification the manufacture of artificial fibre is described. The mass of artificial silk is impregnated with incandescing salts, and squirted or spun into thread in the usual way. The dried threads are then exposed in the vapour of white ammonia, and the mantle is knitted and can be burned off without further treatment.

The principle of the new technical process of converting only a portion of nitrate into hydroxide has been the subject of so much discussion that it should suffice to put forward but a few of the many suggested defects connected therewith. If the fibre contains exclusively nitrate, the structure of the flakes of oxide produced by the somewhat explosive breaking up of this nitrate material during incandescence seems to become spongy in character, and the incandescing body is "puffy" and fragile; the fibre so formed is also hollow inside. This defect is, however, said to be completely avoided if half the nitrate on the surface of the mantle is converted into hydroxide.

One may conceive of a receptacle, formed of any sufficiently refractory and durable material containing the active material which becomes decomposed when heated. This, at least, represents the essential nature of the "armoured" fibre, the inner core of which consists of the incandescing nitrate material.

* G.P. German Patent.

One would suppose, however, that under such circumstances the effect during burning would be exactly the opposite of that claimed, and that the filament would be simply torn to pieces. There are, in addition, other difficulties. How can the inventor determine the exact moment at which the half of the nitrate only has been converted ? How is it possible to wash out the traces of ammonium nitrate without, at the same time, also extracting the very soluble incandescing nitrates from the fibre? Moreover, how is it possible to weave fibres of this nature into thread, and subsequently to knit them into satisfactory mantles ? That these operations are rendered impracticable by such treatment is proved by the existence of patents taken out by Henry Crocker as far back as 1895, and many others.

Knöfler (G.P. 88,556, March 1894) also applied for patents, the essential claim in which was the addition of incandescing salts to the collodion solution, but his methods, too, were proved to be impracticable. According to another patent by the same inventor (G.P.119, 699, March 22nd, 1900 ; B.P.* 5,366, March 21st, 1900), fibres containing only thorium constituents were woven with others impregnated with the cerium-thorium solution. A year earlier Duncan (B.P. 6,919, "Sunlight" patent) recommended a similar plan, but used one strand impregnated with cerium-thorium solution and the other with a solution made up from a mixture of 50 per cent thorium, 40 per cent aluminium, and 10 per cent chromium. This same mixture, however, had been previously specified in the British patent No. 4,243 (February 25th, 1899) taken out by Duncan.

The impregnating of the yarn previous to knitting again finds expression in the British patent 19,957 of September 9th, 1896, taken out by Wellstein, of Berlin. Terrel (G.P. 199,791) and Sepulchre & Co. (G.P. 199,615) describe very similar processes, according to which natural threads, such as cotton and flax, for instance, are impregnated with incandescing materials, immersed in a concentrated ammoniacal solution, and subsequently knitted and burned off leaving an elastic material. It is, however, very difficult to weigh the relative claims of different inventors in these fields ; one not infrequently finds the same process described at different times in patents taken out in various countries and, indeed, even in one and the same country.

At one time the Patent Office (in Germany) regarded it as their duty and right to make a declaration as to how far an invention involved connexion with previous patents. Subsequently the Courts, in several repeated decisions decided that (according to 3, section 1 of the Patent Act), they should only determine whether the subject matter in a specification was wholly or partially identical with that in a former patent. But the additional and distinct question whether the working of the patent involves the use of processes specified under the heading of other patents, is left to the judgment of the courts. The result of this decision was a mushroom-like growth in the number of patents ; for to-day any slight alteration in an already patented process enables a man to put in a claim. In order to define clearly the nature and scope of a patent claimed on behalf of a new invention, however, it is ordered that earlier apparatus or processes implied in the new invention should be referred to in the description. In the cases just mentioned it would have been specially desirable to point out the earlier patents in this field in order to prevent needless misunderstanding.

In patent No. 199,615, the Plaissetty process (G.P. 141,244) for the use of treated natural fibres and thread and web prepared therefrom is protected. However, not only fibres of natural origin, but also artificial fibres impregnated with incandescing materials, and mantles manufactured therefrom ought to be specified, because they, like others, require treatment in the ammoniacal vapour.

According to Patent Law two processes are regarded as "equivalent" when they serve exactly the same technical purpose. It is, therefore,

* B.P. British Patent.

immaterial whether different means are employed in order to attain this end. In the Plaissetty process water is the means of solution adopted. But the substitution of ammonium vapour for the ammoniacal aqueous solution does not constitute a new process, but is only a modification of that described in patent No. 141,244. Even so, such a modification might lead to so great an improvement as to emerge from the existing inventions and be regarded as an original and striking discovery* ; but this can not be said to have been true in the case of that of Sépulchre & Co. process.

This has, however, been accomplished by a recent patent of the Cerofirm Company.

The Patent Office have not upheld the Sépulchre patent for the impregnation of artificial silk webbing, and its subsequent treatment, after drying, with ammonium vapour, but only that involving the treatment of threads or webbing composed of artificial silk that has been previously impregnated ; even this, however, ought not to have been conceded as it is in conflict with the Plaissetty patent 14,244. In this connexion it may be mentioned that four years elapsed before the patent 199,615 was granted, although, under ordinary circumstances, there is not usually more than a year between the dates of application and the granting of the patent.

The application of the Plaissetty process to treated natural fibres, essentially the same as that specified in Plaissetty patents referring to the treatment of artificial fibre, was protected by Terrel in 1902 (G.P. 146,095). It may, however, be remarked that the working up of impregnated cellulose treated by the ammonia process has as yet led to little result, and the Plaissetty Co. first succeeded in manufacturing serviceable mantles out of artificial silk. More recently Terrel seems to have realized this, for in a newer patent (G.P. 199,791, of 1907) he applies the process in question only to mantles that are not burned off previously to being sent out for use. In the case of mantles containing organic fibres, which are to be burned off by the consumer himself, it is essential that the mantle should be so prepared that it does not shrink too much in the process, and that a durable fabric is left behind. In addition the fabric must be such as to be easily ignited by the consumer by applying a match. In order to secure that the mantle burns away to the correct dimensions Terrel collodionises the impregnated and ammoniacally treated mantle, and then draws it upon an iron, internally heated peg, just as Plaissetty has done in the case of the artificial silk mantle.

(To be continued).

* Blatt. f. Patent, Muster, und Zeichenwesen, 1896, pp. 291–295.

Annual Meeting of the Deutscher Verein von Gas und Wasserfachmannern.

The annual meeting of the above society, and also the celebration of the conclusion of the first fifty years of its existence, will be held in Frankfurt a. M., where the society was originally founded, from Monday, June 21st, to Friday, June 25th, of this year. A meeting of welcome to those present will be held in the Council House on the evening of June 21st, and the proceedings will also be terminated by a social gathering on June 25th.

Members are invited to forward to the secretary, by April 30th, papers which they propose to read at the meeting, or any suggestions regarding subjects which, it is thought, might be the subject of profitable discussion. Gentlemen interested in the proceedings who are not members of the society can be introduced as guests on this occasion by existing members.

All particulars are obtainable from : the General Secretary, Dr. H. Bunte Geh. Hofrat, Prof. a. d. Technischen Hochschule, Karlsruhe, Germany.

High Pressure Incandescent Gas Lighting.

By Dr. Hugo Strache (Vienna).

When the incandescent mantle had been just introduced high pressure gas was made use of in order to burn off the mantles at a high temperature and with the object of securing greater hardness and durability. In so doing people could hardly fail to observe the increase in light produced, and naturally attempts were soon made to apply this result in practice. It was, of course, realized then, as it is to-day, that a body brought to incandescence in an air-fed or blow-pipe flame, glows brighter than would be the case for the same body, in the same gas-flame, if the air admitted to the burner were withdrawn. Yet the complete explanation of the increased temperature of the blow-pipe or bunsen flame was not fully understood, though it has since been promoted by the work of Bunte, Mayer and Teichel.*

The degree of heat which can be communicated by the heating gases to the refractory body on which they are allowed to impinge, depends partly upon the difference in temperature between the gases and the body and partly upon the velocity with which the gases referred to flow past it. It is also clear that the temperature the body can attain is primarily dependent upon the temperature of the flame. The flame-temperature in turn is theoretically dependent upon the heat of combustion of the gas burned and the specific heat of the products of combustion. The actual temperature of the flame may differ from the theoretical value from several causes, for instance, on account of a certain indeterminable degree of pre-heating of the mixture of gases supplied to the burner and cooling of the flame owing to radiation. Still, when these factors are borne in mind, it cannot be assumed that the flame-temperature of a gas burning with artificial supply of air must be higher than that of the same flame burning free and in the ordinary way.

We have also to consider the velocity with which the heated gases pass by the incandescent body, and, in so doing, we have to take into account a new factor, to which Bunte first drew attention, namely, the "flame-volume." If the burning of the gaseous mixture takes place in a small space, the volume of the flame becomes correspondingly small. Bunte defined the "flame-volume" as the quantity of burning gases which must be delivered in a unit time in order to develope 100 calories. Although this definition lacks exactitude in that the flame-volume is not only dependent upon the amount of gas burned but also on the velocity of combustion, we can yet draw several useful conclusions therefrom.

The incandescing body must be situated in the actual zone of the flame where the burning actually takes place. If, therefore, the flame-volume is small, the incandescing body must be small too. Now the velocity with which the burning gases impinge upon the incandescent body will be the greater, the smaller the flame-volume. Therefore the amount of heat which is communicated to the heated body in a unit of time will be increased according as the flame-volume is reduced. Again, the entire quantity of heat communicated to the incandescent body will be given up again by radiation into space; therefore, if the former is increased, the latter must be increased too, *i.e.*, the body must attain a higher temperature. Now we know that the light emitted by an incandescent body is proportional to the twelfth or fourteenth power of the absolute temperature; it is, therefore, to the increase in this temperature that the high luminous efficiency of flames provided with artificial air-supply must be attributed. A rise in

* *Jour. f. Gasbel. u. Wasserver*, 1908, p. 265.

temperature is accompanied by a corresponding improvement in the radiant efficiency, *i.e.*, the ratio of energy radiated in a luminous form to the total energy of radiation. We find, therefore, that incandescent gas lights provided with artificial air-supply require less gas in order to yield a certain amount of light.

St. Claire Deville,* in a very exhaustive series of researches, attempted to demonstrate that the illuminating power derivable from a gas, was essentially dependent upon its calorific power. In so doing he employed burners provided with artificial air-supply and adjusted the air admitted to the flame until the maximum lighting effect was secured in each case. Mayer and Schmidt† have improved such burners somewhat, attaining a yet higher result by admitting the exact amount of air to the primary air-stream that theoretical considerations would suggest to be desirable; they also arrived at the conclusion, however, that the proportionality of the illuminating power to calorific value is only approximate, and cannot be applied to ordinary burners which frequently use poor gases, relatively lacking in hydrocarbons, but yielding a higher illuminating value.

The very first experiments that were made with high pressure gas led to exceedingly favourable results. For example Shadbolt, according to a report of Lewes in the year 1903, obtained by burning 500 litres of gas per hour, 773 H.K., *i.e.*, 0.65 litres per Hefner (39 candles per cubic foot). It is very interesting to observe that, in spite of all the improvements which Mayer and Schmidt have introduced, little if any improvement was apparently achieved, for the best result recorded by them in the case of a gas having a calorific value of 5,210 at 0°, was about 0·70 litres per H.K. (37 candles per cubic foot).

Krager,‡ has recently recorded the very favourable conditions at Köln, 0·68 litres per hour per Hefner (38 candle-power per cubic foot) being attained. Yet more recently an improvement has been made in the Keith light, in England, also using inverted mantles and high pressure, and efficiency as good as 0·53 litres per hour per Hefner (48 candles per cubic foot) being obtained, mainly, it is stated, by preheating the primary stream of air.

As has been explained above, the more perfect admission of air into the interior of the bunsen flame gives rise to an improvement in illuminating effect. There remains, however, still the question, what are the best means of obtaining this desirable mixture of gas and air. As we know, the bunsen burner acts on the injector principle, the gas forced in at the nipple under pressure sucking in a corresponding amount of air from outside; by increasing the pressure under which the gas is supplied the amount of air sucked in can be increased and therein lies the principle of high pressure gas lighting. Our object should be so to proportion the parts of the burner as to enable the approximate theoretically correct admission of air to be secured with as small an expenditure of pressure as possible. Possibly in the future the same result that we now obtain by the use of gas under a pressure of 800 to 1,000 mm. of mercury (31·5 to 39·5 inches of water), may ultimately be attained by the use of a pressure only slightly greater than that in use in the ordinary town gas mains. Wedding* has devoted special attention to the distribution in pressure in the burner of the inverted gas light, and improvements in this direction may be awaited.

The first system of high pressure lighting was exemplified by the Salzenberg "Kugellicht," and, by the aid of a pump secured a pressure of as much as 1·1 atmospheres. To-day, however, we have departed from pressures as high as this, for experience has proved that more manageable and moderate pressures give quite as good results.

In the case of all high pressure systems it is very essential to maintain the pressure in the pipes at a quite

* Paper presented at the International Photometrical Commission at Zürich, 1907.

† *Jour. f. Gasbel. u. Wasservers*, 1908, p. 1137.

‡ *Jour. f. Gasbel.*, 1906, p. 1028.

* *Jour. f. Gas. u. Wass.*, 1908, p. 193.

uniform value, even when the distributing pipes are more or less loaded in certain quarters owing to the lighting up or extinguishing of lamps. The newer systems are distinct from those of former times mainly in the means adopted to regulate the pressure. In the well known Millenium system the regulation is accomplished by means of floats which rise and fall with the level of water in a vessel communicating with the general gas-supply. The regulation of pressure can be accomplished without the use of water, however, as the experience of the Gas and Electricity Co., at Köln, for example, has shown. Some account of this system has been given by Krager (*loc. cit.*) It would, however, lead us too far astray to attempt even to mention all the devices that have been adopted for the regulation of pressure to a constant value.

There are, however, other means of obtaining the desired more perfect mixture of gas and air, without putting the gas supplied under high pressure. Mention may first be made of the Selas system of gas lighting, which was described by Lewes in 1903; an intensity of 873 H.K. was said to be obtained with a consumption of gas of 472 litres per hour, *i.e.*, 0·54 litres per hour per Hefner. In the Selas system a mixture of gas and air is maintained in the gas-pipe and the requisite proportions of gas and air can be obtained with a relatively low pressure. One can either compress the gas and air previous to mixture or compress both in the required mixed condition. The system has been described by Bertelsmann,* who, however, obtained only 100 H.K. when burning 75 litres per hour—a distinctly lower efficiency than that recorded by Lewes.

Another method of solving the problem of perfect proportions of gas and air utilizes a supply of compressed air only, admitted to flames burning gas under the ordinary pressure. The Pharos light is one of the best known examples of this system. Klatte† claims to have obtained 0·5 to 0·7 litres per hour per Hefner, using upright mantles, and even 0·4 (65 candles per cubic foot of gas) is said to have been attained in the case of inverted lights. In view of the results of St. Claire Deville, Mayer, and Schmidt, who utilized the theoretically most perfect admission of air in order to secure complete combustion, these figures must, however, be regarded as requiring verification. This system, involving the supply of air under a pressure of 1,500 mm.pressure (39·5 inches of water) through very thin pipes, presents the advantage that no alterations in existing low pressure installations are necessary. The high pressure air, it is claimed, can also be very readily supplied to consumers, while ordinary high pressure gas lighting is, in general, only used for street lighting.

High pressure air, in addition, need not pass through meters, and can be supplied to consumers for a monthly inclusive fee of three to six mks. per light.

Yet another method of promoting the complete mixture of gas and air, the admission of the correct amount of air to the burner, is that of Lucas who utilized the draught of an unusually long chimney. More recently the same result has been attained in this lamp by the use of a fan in the base of the lamp, worked by a small electromotor, which is in turn actuated by the current generated by a thermopile placed in the upper portion of the lamp. Wedding records an efficiency of 0·87 litres per hour per Hefner (horizontal) for this lamp. Salzenberg has also recently applied the thermopile to the increasing of pressure in a similar way.

High pressure inverted gas lighting has won a very extensive field for itself of recent years. It was at one time almost exclusively used for street lighting, high candle-power lamps of perhaps 1,000 to 4,000 H.K., capable of serving similar purposes to those for which the electrical flame arc lamps are intended, being largely utilized. In the last few years there has been much discussion, in Germany, in which Drehschmidt, Krüss, Uppenborn and Bloch have participated, as to whether

* *Jour f. Gasbel.*, 1905, p. 397.
† *Jour. f. Gasbel.*, 1906, p. 1032.

the extensively used high pressure gas lighting in Berlin was preferable to illumination by electric flame arc lamps. This discussion has at all events proved that the use of high pressure gas has enabled gas lighting to compete with electric arc lamps, for purposes in which concentrated sources of high candle-power are required, which at one time it was unable to do.

High pressure gas lighting will probably always be of limited application, in the case of interior lighting and only employed when the large consumption of gas leads the householder to practise economy, and when this economy in running costs justifies the initial expenditure.

It will, however, only be when we have succeeded in distributing gas for general purposes at high pressure so that it is at the disposal of consumers in the same manner as is ordinary gas at the present day, that the private consumer will utilize its advantages to any great extent.

Co-operation between Competitors.

By a German Correspondent.

A correspondent from Berlin sends us some particulars of the state of trades connected with illumination in Germany. In common with other countries, he says, Germany has suffered from the prevailing economical depression, and, in the case of the illumination industry, this has been accentuated by the proposed tax on illuminating apparatus, which, however, has now been definitely rejected. Naturally, therefore, of late years, efforts have been made to economise by co-operation.

The success of the Auer Company is in no small measure due to the fact that they have taken up electric lighting in addition to the manufacture of mantles, &c., to which they originally confined their efforts. A great step was taken in the formation about fifteen months ago, of a union of firms connected with different departments of lighting for the purpose of regulating prices and co-operating for their mutual benefit. The society includes sixty-six of the largest firms, directly connected with lighting by different methods, who work in harmony for a common object, many allied trades, such as the manufacture of lamp-globes, &c., for illuminating purposes, by glass-makers, and of wicks by the textile trade, being also interested in the movement.

In Germany the prevailing tendency is more and more towards concerted action of this description, which is replacing the cut-throat competition of former times. Another instance in point is the organization of a special annual display at the Leipzig Industrial Exhibition, by a collection of electrical firms of various kinds. In the last exhibition, 1,300 German firms and 210 foreign ones exhibited, and it is anticipated that this number will be largely increased this year.

The combined action of the electrical firms mentioned will result in a considerable saving to individual exhibitors, especially in the way of advertisements, and propaganda, &c. A special feature of this exhibition will be the concentration of exhibits relating to lighting of all kinds in one building, instead of their being scattered in different buildings as heretofore. This is an interesting recognition that illumination is now coming to be looked upon as a subject in itself; it is now recognized that there are many people who are interested in all kinds of illuminating apparatus, and that manufacturers of different specialities can be of great assistance to each other. For instance, in an exhibition of this kind, the manufacturers of glow-lamps and incandescent mantles, &c., gain an opportunity of co-operating with others who specialize in glassware, shades, or fixtures of special character. And it is, of course, of inestimable benefit to the consumer to be able to study all the appliances for illumination in which he is likely to be interested, in one and the same building.

The Present State of Metallic Filament Lamps.

By Our Paris Correspondent.

Metallic filament lamps continue to be the subject of much discussion among engineers. Prof. Blondel, in a report recently presented at the last International Congress of Electricians in Paris, gave an up-to-date survey of our present knowledge of their manufacture and properties.

Investigators in the past years, it is pointed out, were unable to make any considerable progress in consequence of their holding several ideas that were fundamentally erroneous. Recent study of the subjects of ionization and radiation have, however, removed these barriers, and now inventions are numerous, and progress rapid.

The methods now in use in manufacturing metallic filaments may be classified as follows :—

Direct Methods, in which the Filament is formed directly from Metallic Materials.

1.—Metals drawn out in Wire, such as Tantalum, in a pure Condition.

Patents have recently been taken out for drawing Tungsten in this condition, or in the state of an alloy, the added material being subsequently removed by additional treatment.

2.—Filaments prepared by Squirting the Metal in the Pure State.

Kuzel has prepared a gelatinous paste of the metal in a colloidal condition. This paste is forced under-pressure through a diamond die, and the filaments are afterwards heated *in vacuo* and rendered conducting.

3.—Filaments formed from Materials in an Impure State.

According to these processes the metal is reduced to a finely divided state, and made into a paste with some organic binding material ; this is afterwards removed by suitable treatment (Auer patent, Osram).

4.—Filaments formed from Oxides and other Metal Compounds.

After being first formed into a filament the material is subjected to appropriate chemical changes in order finally to obtain the metal to the pure state (patents of Lux, A.E.G. French Auer Co.).

Indirect Methods.

According to these methods the filament, which is usually composed of carbon, is afterwards transformed into a metallic condition.

1.—By Deposition and Decarburation.

The discharge of the current through a filament of carbon brought to incandescence in a vessel containing vapours of the chlorides of tungsten precipitates this metal on the carbon. By subsequent processes the carbon is got rid of by exidation, pure tungsten remaining (patent Just & Hanaman).

2.—Substitution Methods, which bear a general resemblance to the preceding Process, except that both Operations take place simultaneously.

Metallic filaments still present great difficulties of manufacture owing to their fragile nature, and also to the high conductivity of tungsten. This renders it still essential to compose the lamp of several distinct filaments mounted in series, each provided with an appropriate support. In spite of recent progress the metallic filaments lamps are as yet not in the position to replace incandescent mantles from the point of view of economy pure and simple. On the other hand, the over-rapid development of metallic filament lamps might prove inconvenient to electrical supply companies. We have yet to see works capable of turning out 110-volt lamps consuming less than 25 to 30 watts. The relatively small decrease in revenue which has followed the introduction of the lamps in their present state, in place of the old carbon filament ones, has been compensated for by the increased amount of light, and the new consumers derived. The tungsten lamps can only with difficulty be made for 220 volts. Not only is their consumption per candle-power invariably higher under these conditions, but their useful life is also reduced.

So much is this the case that one would certainly now hesitate to recom-

mend the adoption of high supply-pressures in the case of new installations. Of course, it is true that in the case of alternating current this inconvenience in the lamps,from the consumer's standpoint, is partially remedied by the use of step-down transformers. Transformers are specially applicable in cases when they can be applied to a certain group of lamps, which are all in use together: the Weissman "Economizer," for instance, can be applied to individual lamps or chandeliers, reducing the pressure from 110 to 20 or 25 volts, and thus secure the advantages of the cheap and stout filaments which can be used at this pressure. In what follows the writer communicates the results of some tests carried out by Mons. F. Laporte in the Laboratoire Central d'Electricité on metallic filament lamps.

The ten different kinds of lamps of this kind actually made in Paris (Osram, Osmine, Sirius - Kolloid, Philips, Orion, Fulgara, Canello, Z., Metal) have been made the subject of many experiments.

During these tests the connexion between candle-power and the pressure of five different types of lamps was studied, very similar results being obtained in the case of all varieties of tungsten lamps.

The filament of the 110-volt tungsten lamp first becomes visible when the pressure occurs about 4 volts; a tantalum lamp intended for the same P.D. at 6 volts; and a carbon lamp at 19 volts. The connexion between pressure and candle-power in the case of different lamps is given in the following table :—

Change in candle-power caused by 1 per cent change in P.D.

6·5 to 5·8 % carbon filament.
4·3 to 3·9 % tantalum filament.
3·8 to 3·6 % tungsten filament.

In the numerous tests that have been undertaken by the Laboratoire Central d'Electricité, a commercial type of lamp, which,when run at the pressure indicated by the manufacturers, gave the specific consumption of 1 watt per bougie décimale, was never encountered.

The following figures are the mean of a series of results extracted from those obtained at the laboratory :—

Type.	No. of Lamps Tested.	P.D. Volts.	Power Consumed Watts.	Intensity Bougies Décimales.	Watts per Bougie.
B	7	110	30·4	18·5	1·64
C	20	110	44·5	33·4	1·34
D	9	115	34·7	29·0	1·20
G	10	115	37·9	29·5	1·30
H	10	115	35·4	28·6	1·24

It will be seen the specific consumption for lamps of 110 volts varies from 1.2 to 1.8 watts per bougie décimale, and it may be remarked that for lamps of pressures of 110 to 115 volts the actual consumption has been found to vary from 25 to 30, or even, in a few instances, to be as low as 21 watts.

Tests in a laboratory, however, rarely yield results which are directly applicable to the behaviour of metallic lamp filaments under conditions of actual practice.

For instance, from this point of view, it is difficult to reason from photometrical life-tests systematically carried out on a constant P.D., because it is usually the actual breakage of the filament and not the diminution in candle-power which brings about the end of its useful life: moreover, the influence of the very considerable variations which are inherent in the ordinary supply-pressure make it difficult to draw conclusions from laboratory tests carried out on an exactly constant P.D.

Tests carried out on a continuous current circuit and at a really constant P.D. have shown that lives of 1200, 1300, or even 1,500 hours are obtainable with but trifling diminution in the initial candle-power. During the past year about 60 lamps of different types have been successfully put into actual use on the lighting system of the Laboratoire Central d'Electricité, which consists of an alternating current at a frequency of 42.

The variations in the pressure were probably the origin of the breakage of a certain number of filaments. The lamps of the five makes tested display qualities distinctly different during their life: all those, however, which are still in existence—even those which have run for the longest time—appear to have neither gained nor lost any appreciable amount of their initial intensity.

The Selective Emission of Incandescent Lamps as Determined by New Photometric Methods.

By E. P. Hyde, F. E. Cady, and G. W. Middlekauff.

(A paper presented at the February meeting of the New York section of the Illuminating Engineering Society.)

(*Continued from p.* 243.)

The second method of establishing a positive qualitative criterion of selectivity starts from the same condition which was described above in connexion with the first method, namely, that the temperatures of the filaments be so adjusted that the distribution of energy in the visible spectrum is the same for both.

If the energy curves of the two filaments are similar throughout the entire spectrum and if, as above, all of the energy supplied to the lamp is transformed into radiant energy, it is probable that if the electrical power supplied to each filament be increased by the same percentage amount, the proportion of the added power which will go into the visible spectrum will be the same for each filament; that is, if the lumens per watt are the same originally and the total wattage be increased by the same percentage for the two filaments, under the new conditions the lumens per watt would again be the same for the two filaments, so that the percentage change in flux corresponding to a definite percentage change in electrical power supplied to the lamp would be the same for the two filaments.

If, then, there are two filaments, one having unknown radiating properties and the other having the properties of a black body, and if these two filaments be brought to the same distribution of energy in the visible spectrum and the change in flux corresponding to some definite percentage change in watts supplied to the lamp be determined, it is probable that if the percentage change in flux for 1 per cent change in watts is the same for the two, the filament of unknown radiating properties will in all probability have the properties of a grey or black body.

Conversely, if the percentage change in flux corresponding to 1 per cent change in watts supplied to the lamp is different in the two cases, one lamp must be radiating selectively with respect to the other.

Since the percentage change in flux is the same as the percentage change in candle-power in any specific direction, and since it is much simpler to determine change in candle-power in one direction than to determine the change in flux which necessitates the use of some integrating method, the measurements made by the second method were confined to determining the change in candle-power corresponding to a 1 per cent change in watts. The results are expressed in this way in the accompanying tables.

The coefficient of change in candle-power corresponding to 1 per cent change in watts has frequently been determined for filaments of different materials; but a comparison of the resultant coefficients when the two filaments have the same distribution of energy in the visible spectrum, and the deduction from the results as to the selectivity indicated by a comparison of the coefficients under this condition have never previously been made. This, then, constitutes a second qualitative method of determining positively whether or not one filament radiates selectively as compared with the radiation from a second filament.

In both methods the starting point has consisted in bringing the two filaments to the same distribution of energy in the visible spectrum by means of spectro-photometric measurements. The same result can be accomplished, however, in a very much simpler manner. The eye is very sensitive to slight differences in tint. If, therefore, a lamp at a definite voltage be placed on one side of a Lummer-Brodhun photometer screen and the voltage of a second lamp placed on the

other side of the screen be varied, one can determine with considerable accuracy when the second lamp has the same distribution of energy in the visible spectrum as the first lamp, by varying the voltage until the two sides of the photometer screen appear to have the same tint. In fact, this method of bringing the two lamps to the same distribution of energy in the visible spectrum is perhaps more sensitive than the spectro-photometric method, and yield results in entire agreement with the latter so far as measurements made by the authors indicate.

It is quite a simple matter, therefore, to compare the relative selectivity of two lamp filaments by either of the two methods given above. Thus, subjecting one filament to some definite voltage, the voltage of the other filament at which its light has a colour match with the light from the first filament is determined. Then according to the first method the total luminous flux and the watts supplied to each lamp are measured and the lumens per watt are calculated. If the two values are the same, the lamps are relatively not selective. If the two values are different one lamp is selective with respect to the other. By taking as a standard lamp a carbon-filament which approximates a black body and is not selective to any extent, one can determine whether the radiation from another filament is, or is not, selective. The results of an investigation of a number of kinds of filaments, using both of the methods, are given in Tables I., II., and III.

The investigation is not yet complete, but the results obtained thus far are quite interesting.

The method of procedure was as follows: It was desired to compare the radiating properties of the filaments at different temperatures, but in order to avoid at the beginning of the investigation any direct temperature measurements, the authors selected as arbitrary temperatures, those temperatures which a particular carbon filament had at three or four definite voltages over a considerable range of voltage. Thus a comparison was made of the radiating properties of the various filaments when they were at a colour match with the standard lamp at 75 volts; again, when they were at a colour match with the standard lamp at 100 volts; again, when they were at a colour match with the standard lamp at 125 volts. Finally it was the intention to make a comparison, if possible, when they were at a colour match with the standard lamp at 150 volts, but these measurements have not been undertaken as yet.

The standard lamp was a treated carbon filament consuming about 3·5 watts per candle at 110 volts. As this lamp has been used for many hours during the progress of the investigation it is possible that it has undergone some change in colour since the investigation was begun. Moreover, some of the measurements were made under conditions that were not entirely satisfactory, so that, although the general conclusions are probably quite definitely established, the numerical results given in the tables may not be of a high accuracy. It would be desirable to repeat the entire series of measurements, carefully selecting the most suitable lamps and arranging the conditions of the measurements so that results of the highest accuracy could be obtained.

In actually carrying out the measurements, the method was to determine for each lamp the voltage at which it matched in colour the standard lamp at 75 vols (Table I.); then, operating these lamps at the determined voltages to measure the lumens per watt, and the coefficient of change in candle-power corresponding to 1 per cent change in watts.

In the first column are given the different types of lamps studied. Of each type there were at least two, and in many cases three or four lamps. In the second column are given the red black-body temperatures as determined at the beginning of the investigation of Drs. Waidner and Burgess of the Bureau of Standards by means of an optical pyrometer; they are probably accurate to within 10 degrees, but should not be insisted upon to a much higher accuracy.

In the third column are given the percentage change in candle-power corresponding to 1 per cent change in watts, expressed, however, in terms of a unit so chosen that for the untreated carbon filament the coefficient has a value of unity, the absolute value of this coefficient being 3·9. By expressing the results in this way it is easier to see the relative differences among the different types of lamps.

In the fourth column are given the lumens per watt expressed again in terms of such a unit that the lumens per watt for the untreated filament is taken as unity the absolute value being 0·38. The results are quite interesting.

TABLE I.

Average values obtained on lamps of each type at voltages corresponding to a "Colour Match" with the Standard Lamp at 75 volts.

Types of filament	Red black-body temperatures.	Relative per cent change cp. for 1 per cent change in watts	Relative lumens per watt.
Untreated carbon	1420 C.	1·00	1·00
Helion	1405	1·00	0·97
Treated carbon	1395	0·97	1·06
Gem	1400	0·98	1·05
Tantalum	1340	0·83	1·28
Tungsten	1345	0·79	1·49
Osmium	1390	0·80	1·85

TABLE II.

Average values obtained of lamps of each type at voltages corresponding to a "Colour Match" with the Standard Lamp at 100 volts.

Types of filament	Red black-body temperatures.	Relative per cent change cp. for 1 per cent change in watts.	Relative lumens per watt.
Untreated carbon	1680 C.	0·86	3·85
Helion	1650	0·85	3·85
Treated carbon	1645	0·84	4·15
Gem	1650	0·84	4·0
Tantalum	1570	0·72	4·35
Tungsten	1555	0·71	5·25
Osmium	1610	0·69	5·9

TABLE III.

Average values obtained of lamps of each type at voltages corresponding to a "Colour Match" with the Standard Lamp at 125 volts.

Types of filament	Red black-body temperatures.	Relative per cent change cp. for 1 per cent change in watts.	Relative lumens per watt.
Untreated carbon	1890 C.	0·76	9·0
Helion	1850	0·75	9·2
Treated carbon	1855	0·74	9·5
Gem	1855	0·76	9·4
Tantalum	1765	0·65	10·0
Tungsten	1740	0·67	11·5
Osmium	1800	0·65	12·5

Thus, from the data given in column four it will be noted that when these various types of filaments have the same distribution of energy in the visible spectrum, the lumens per watt range from unity to 1·85

If there were no relative selectivity, the lumens per watt would be unity for every type. There is marked evidence, therefore, that there is considerable selectivity among the different types of filaments, and it is quite interesting to note the order in which the filaments arrange themselves. A higher value of lumens per watt, as for example the value of 1·85 for the osmium lamp as compared with 1·00 for the untreated carbon filament, indicates that when the osmium filament has the same distribution of energy in the visible

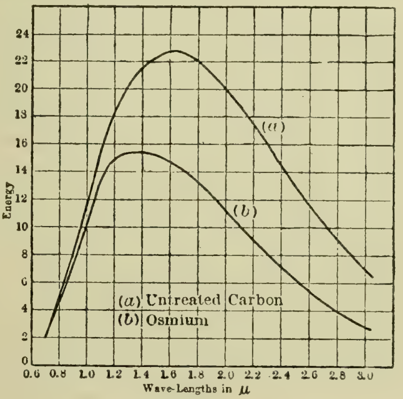


FIG. 1.

spectrum as the untreated carbon filament, the energy curve of the osmium lamp drops off considerably in the infra-red as compared with the energy curve of the untreated carbon. In other words, the osmium radiates selectively in favour of shorter wave-lengths, that is, in favour of the visible spectrum, and is, therefore, a more efficient luminous radiator than an untreated carbon filament.

An interesting experimental confirmation of this conclusion was also obtained through some measurements made by Dr. Coblentz of the Bureau of Standards. Taking the two filaments carbon and osmium, at voltages which had been determined as giving the same distribution of energy in the visible spectrum, he determined the

energy curves in the infra-red, plotting the two curves thus obtained in such a way that the energy radiated in the red end of the visible spectrum was taken as the same in the two curves. It was found that the infra-red curve of the osmium filament is considerably depressed in the region of longer wave-lengths as compared with the curve of the carbon lamp. These two curves are shown in the accompanying illustration.

It would appear from the table that the Helion lamp is, if anything, less selective in favour of shorter wave-lengths than the untreated carbon. The small difference, however, between 1·00 and 0·97 may be accounted for by experimental error, so that one might say that the Helion filament behaves very much like the untreated carbon filament. It should be explained, however, that the Helion filaments which were used in this investigation were quite old, and it is barely possible that the deposit of silicon had entirely disappeared, and that we were studying the properties of the base carbon, which would readily explain the results which were obtained.

The treated carbon and the Gem filaments are more selective than the untreated carbon; the tantulum considerably more selective; the tungsten still more so; and, finally, the osmium most selective of all. It is very striking that despite the relatively large experimental errors which may enter into these measurements, the filaments arrange themselves very closely in the same order of selectivity when use is made of the second method of determining selectivity as found by the first method.

Thus, in the third column, the percentage change in candle-power corresponding to 1 per cent change in watts is about the same for the untreated and for the Helion filaments. It is slightly less for the treated carbon and the Gem filaments; considerably less for the tantalum; and still smaller for the tungsten and osmium filaments. The only apparent discrepancy is that the tungsten filament has a lower co-efficient than the osmium, which is the reverse of what was found by the other method. This result might readily be accounted for in two ways. In the first place, the coefficients as given in the third column are in no way as widely different as the values of lumens per watt given in the fourth column, and a slight error in determining the coefficient might account for the difference in the relative results obtained by the two methods for the tungsten and osmium filaments.

In the second place, so far as we can see now, there is no definite reason why the quantitative results obtained by the two methods should be the same, for, granting that two filaments are selective as compared with a black body, the nature of the selectivity may be different. Thus, it may be that the energy curve of one filament is suppressed throughout the entire infra-red spectrum to approximately the same extent, whereas in the case of the other filament the suppression may be exaggerated in some particular region of the infra-red spectrum. Such differences would seem to be sufficient to account for small quantitative differences in the selectivity as determined by the two methods.

In Table II. the data are given for the same lamps at a colour match with the standard carbon lamp at 100 volts, the numerical values given in the third and fourth columns being in terms of the same units as those used in Table I.

It is interesting to note that here again and by both methods the filaments arrange themselves in the same order as found at 75 volts, but that the numerical differences are considerably smaller. Thus, at 75 volts the value of lumens per watt of the osmium lamp is almost twice that of the untreated carbon lamp, whereas, at 100 volts it is approximately one and one-half times that of the untreated carbon lamp.

Again, according to the data in Table III., which were obtained for the same lamps at a colour match with the standard carbon lamp at 125 volts, the filaments arrange themselves in the same order as found at the two lower voltages.

The authors wish to emphasize again the fact that the numerical values

given should not be trusted to too high an accuracy, as some of the lamps were used for quite a long period and showed marked evidence of deposit on the bulb. The uncertainty becomes greater, of course, as the temperature increases, since the disintegration of the filament proceeds much more rapidly at the higher temperatures. The voltages at which the carbon filaments were operated to match in oclour the standard carbon at 125 volts were well beyond the normal values for the lamps, while the metal filament lamps, even at the highest temperature used, were still operating below normal voltage. However, some of the tantalum lamps showed marked deposit.

That no serious error was caused, however, by the deterioration of the lamps is shown in two ways. First, the filaments arrange themselves in the same order at the highest temperature as they do at the lowest, when they were operating well below their normal working temperatures, and had suffered no disintegration. Secondly, the coefficients of change in candle-power corresponding to 1 per cent change in watts would not be affected to any great extent by a deposit on the bulb, and in almost every case, as pointed out before, the filaments arrange themselves in the same order by both methods.

The one method, that of determining the lumens per watt, is the more sensitive when the experimental conditions are very carefully determined. The other method, while less sensitive, is, at the same time, much less dependent on the experimental conditions. Slight blackening of the bulb, appreciable loss of energy by conduction at the leading-in and anchor wires, and the errors in the wattage of the filaments introduced by bad contacts between the leading-in wires and the filament, would probably make but little difference in the values obtained for the coefficient of change in candle-power corresponding to 1 per cent change in watts. These errors would probably be insignificant compared with the marked differences between the coefficients of the untreated carbon lamp and those of the osmium lamp, for example. There can be little doubt but that the arrangement of the filaments given in Tables I., II., and III. is substantially correct, though the numerical values found as a result of a more extended investigation might be somewhat different.

(*To be continued.*)

The Tax on Light in Germany definitely Rejected.

A German correspondent writes to draw our attention to the decision of the German Reichstag, announced at the end of last March, to reject the projected tax on illuminating apparatus, which has proved so unpopular among the many trades and professions interested.

The suggested tax formed the subject of much criticism in the German technical press, and was also discussed in *The Illuminating Engineer* (vol. ii., January, 1909, p. 23). It was freely predicted that it would prove a great hindrance to the development both of the gas and electrical lighting industries as well as to a large number of trades more or less directly concerned, and that the revenue derived therefrom could not compensate for the injury it would cause. The innumerable petitions against the tax appear to have been successful.

Whilst reluctant to enter into matters which are, strictly speaking, only the concern of the particular countries affected, we have felt that the imposition of a tax on light—which is a necessity and not a luxury—has been rightly regarded as a short-sighted policy, and would have formed a very undesirable precedent. The authorities would seem to have acted wisely in acceding to the very general request for its rejection.

Some Experiments on the Growth and Decay of Colour Sensations.

By an Engineering Correspondent.

The Illuminating Engineer is necessarily interested in any physical or physiological phemonenon of the eye, and an account of some of the author's experiments may therefore be of interest.

These simple experiments can easily be repeated by any one, but nevertheless it was a long time before a full and satisfactory explanation of them occurred to the author. His object, in these researches, was to frame a theory to explain the action of a top discovered by Mr. Benham in about 1895.

The experiments clearly show that the sensations transmitted by nerves, forming the different colour sensations perceived by the eye, have different rates, both of growth and decay—*i.e.*, a red sensation may appear sooner than one of either green or blue; but it may be the first to decay, while a blue sensation may last longest. The experiments show that the rates are in this order.

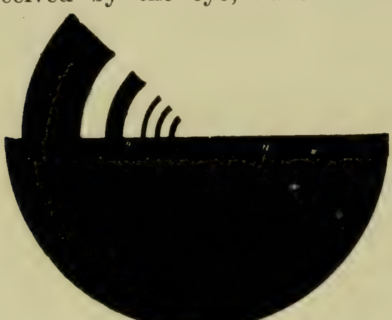


Fig. 1.

The effect of Contrast.

When the disc shown in Fig. 1 is slowly rotated and observed at a distance of about one metre, the innermost lines appear coloured while the outer lines are grey. However, if the disc is observed from a much greater distance the other bands appear coloured. This shows that the colour is dependent on the angular breadth of the lines, which are here called sector lines. From this it appears that the phenomena depend on a contrast with the white background.

An example of contrast is furnished by a blue patch on a white ground, which will give the immediate surrounding white a reddish tint and thus appear to increase the blue.

Effect of position on the Sector Lines.

The disc shown in Fig. 2 is slowly rotated, and upon observation it is noticed that all the sector lines are the same colour, showing that their radial distance has no effect on the colour.

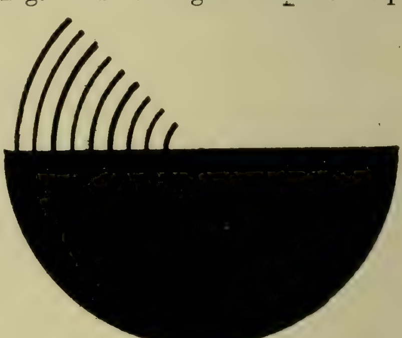


Fig. 2.

Fig. 3 is a diagram of the "Spectrum Top," as made by Mr. Benham; when this is rotated it is observed that each series of sector lines has a different colour. This shows that the colour is dependent on the position, or, in other words, on the ratio of the amount of white following and preceding the sector lines.

Effect of Speed of Rotation.

The speed of rotation that gave the best colours was found from experiments with the disc of Fig. 3. It appeared that the slower the rotation the clearer was the colour, provided that a continuous impression was pro-

duced on the eye, and it seems that about six revolutions per second is the best speed.

Theory of Experiments.

It seemed probable that the red possessed the most rapid rate of growth; further, when the arrangement shown in Fig. 2 was suddenly put in motion in an anti-clockwise direction of rotation, the lines have a faint red following.

Now if the rates of growth of the three colour sensations are in the order red, green, and blue (red being the colour to grow and decay most rapidly), it is easy to account for all these colour phenomena.

As the action of the disc of Fig. 2 is the simpler this will be considered first. It must, however, be made clear what is meant by the terms "sensation" and "impression." The "sensation" refers to an excitement of one particular set of the colour nerves, whereas the "impression" refers to the total effect on the eye. Thus one orange impression is caused by several different sensations.

Let the disc be given an anti-clockwise rotation, and suppose the eye (as it must be) directed to one point. Then the following series of images pass before the eye :—

1. The black sector disappears and would give rise to a general red sensation, if there was a contrast, but in its absence the sensation is negligible.

2. The sector lines disappear, giving a red sensation in their place, visible by contrast with the background, which by this time has become white.

3. The black sector comes into view, covered with a blue sensation, which is again negligible owing to the absence of a contrast. The total impression will be red lines on a white ground.

If the direction of rotation be reversed the effect will be dark blue lines on a white ground. This is caused by the remaining sensation of the white on the black sector lines, and is a complete reversal of that described above.

The blue colours are always darker than the others, because they are seen on a black ground.

It is slightly more difficult to account for the colour seen when Fig. 3 is rotated.

Again, giving the disc an anti-clockwise rotation, the colours are purple, dull-orange, and violet-green, counting from the centre.

The explanation given above accounts for the first colour, but the others must be separately considered, assuming as before that the eye is directed to one point.

The series of images given by the second set of sector lines is treated next.

The black sector passes away, but, as previously explained, there is not a colour effect. Then, after a certain amount of white (45°), the sector lines appear, giving rise to a blue sensation. This is quickly followed by a red sensation, when the lines disappear from view. The appearance of the black sector does not give a colour effect.

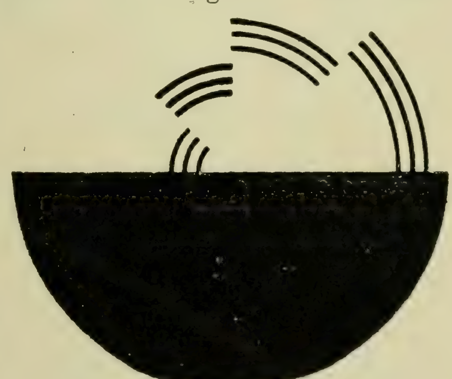


Fig. 3.

These blue and red sensations will combine to give an orange impression, for the red sensation is much greater than the blue. This is because the intensity of the sensation naturally depends on the size of the white sector.

The colour of the third set of sector lines is explained in a similar manner. In this case the sensations will be exactly as in the second series, except that the magnitude differs. The resulting impression is a blue-green colour.

The fourth band is blue, as previously explained.

This colour phenomenon was studied and the explanation deduced entirely from observations under monochro-

matic light, as it is always desirable to leave some means of checking a theory.

In the consideration of illumination with coloured lights, it is necessary to remember that even a monochromatic light may affect all the colour nerves.

Since making these experiments some other work on the subject has been discovered, among which are some observations of Sir W. de W. Abney* under different coloured illumination.

These observations support the theory that has been advanced, and incidentally show the practical value of the three colour theory.

* *Nature*, June 24th, 1895.

Other work has been done on this subject, but this is the first complete theory of the top.

It is very gratifying to the author to be able to state that Mr. Benham has expressed his entire support of this theory.

There is not any clear practical use at present for the Benham top. Such effects, however, ought to be more widely known, as they illustrate, in a simple manner, a new class of phenomena, and may have an important bearing upon the theory of the flicker-photometer and other apparatus, in which the eye is subjected to a light of fluctuating intensity.

F. P. S.

The Use of Electric Light for Decorative Display.

The possibilities of using light for decorative and spectacular purposes are very considerable, and, indeed, still present, in many respects, an almost unexplored field. In the United States the use of light on special festive occasions has been a special feature for some time, and a recent number of *The Electrical World* contains some descriptions of the efforts that are being made in various cities in that country to celebrate forthcoming events by this means.

It may be noted, for instance, that one such device to be exhibited at the Southern Electrical and Industrial Exposition, held in Louisville on April 21st to 24th, consists of an electrical clock (said to be the largest in existence) with a pendulum 35 ft. long and a dial 25 ft. in diameter. But the dial is to have no hands. The hour and minute will be indicated by numbers outlined in incandescent glowlamps of various colours and automatically regulated by electricity. At the same time the periodical extinction, one by one, of rows of lamps will denote the fleeting seconds.

Another scheme on foot is the improved electric illumination of Niagara Falls by the aid of searchlight batteries, one of which is to be installed in a specially built recess in the Canadian cliff opposite Goat island.

Yet another case is furnished by the preparations for the coming Hudson-Fulton celebration in New York, where the question as to the character of the illuminations to be adopted is receiving very careful attention. The relative merits of "outline-lighting" by the aid of incandescent lamps and of illumination of the exteriors of buildings, and especially memorials of historic interest, by searchlights, are being discussed, and it has also been suggested that mercury vapour lamps should be utilized among the foliage of the trees in the parks.

Whatever be the feeling as to the artistic merits or otherwise of existing schemes of decorative illumination, it must at least be felt that the time has come when the use of light on festive occasions as a decoration ought to be taken seriously, and it is gratifying to see that they are being vigorously discussed across the water.

At the present time one finds very wide differences of opinion existing in the public mind, the same system of illumination being hailed as the last word in artistic creations by some and regarded as barbaric by others.

Ere long, no doubt, the objects of decorative lighting will be more perfectly recognized, and the artistic principles involved more clearly defined. There is certainly room for expert guidance in the matter.

REVIEWS, ABSTRACTS, AND REPRODUCTIONS.

A British Illuminating Engineering Society.

(From *The Electrical World* of New York, March 18th, 1909.)

We are glad to note that steps have been taken toward the formation of an active British society devoted to illuminating engineering. There has been a great deal of activity in practical illumination among our British confrères. London is at present, in fact, a gigantic station for the trial of new illuminants, and there exists a good reason for the organization of those interested in pushing along the cause of practical illumination. The same objections raised here three years ago are heard in London—that illumination is not an art at all, but a trade ; that nobody wants the services of a specialist to tell him about things he already knows ; that an illuminating engineer is nothing but an electrical engineer with a little common sense, &c. These various protests are now merely cause for smiling, for the new profession has proved already its right to be taken seriously, and its capability for good. The past three, years have shown progress in good lighting to an extent that was hardly imaginable at the beginning of the period. And it is but the beginning of future improvements. The story of the British society will be a very similar one, and in it will be brought together as here the most diverse interests working together for a common end. In spite of predictions to the contrary, gas engineers and electrical engineers will join hands, there as here, if not with rivalry forgotten, at least with cordial good will and interest.

The fact is that illuminating engineering requires a deal of specialized knowledge that does not lie within the natural field of any other branch of engineering. It is, moreover, near enough to a fine art to demand some special gifts that few men possess. The late Luther Stieringer, for example, had a fine artistic instinct for harmonious and brilliant effects, that came through no special training in engineering, and that no engineer has at all equalled. One of the most serious questions to-day is how to find and train men who shall know what to do with artificial light beyond the mere technique of wiring in piping. Our British friends have this problem before them just as we have here, and there is as yet no definite answer. Technical schools have, with a few notable exceptions, thus far fought rather shy of offering courses on illumination. The subject does not belong to electric engineering more than to chemical engineering or architecture, and hence it is not easy to fit it into any particular place, without elbowing out something that is supposed to be more appropriate just there. In course of time all this will be changed, but for the present it is mostly a case of self-education, which is a mighty good kind of education when one is a conscientious instructor. The British society has, like our own, wisely disclaimed the formal title of "Illuminating Engineers," and calls itself merely the Illuminating Engineering Society. It might well go a step further and discourage the promiscuous use of the title of Illuminating Engineer, save by those who have serious right so to denominate themselves. Our own society has been devoting much consideration to this very subject. It is unfortunately the fact that purely for trade purposes the title has been very improperly used. We heard the other day of a concern that loudly proclaimed that it had forty "Illuminating Engineers" in its employ. This would be a joke were it not in such execrable taste. The two societies can do excellent work in suppressing this sort of noisy boasting by precept and example. They can also well devote some energy to a propaganda for education in illuminating matters, to the end that there may be a supply of well-trained men for the future needs of the art.

The British society starts out with influential friends and with a degree of enthusiasm that speaks well for its future. It has before it a vigorous campaign of education, and plenty of hard work. But in some respects its position is encouraging. It is in closer touch with the rapid development of things on the Continent than we are here. There is much activity in the use of new illuminants, and a stiffer fight between gas and electricity to keep things moving. There is also plenty of interest in engineering in all its branches and a better opportunity for engineers to get together than there is in our own country. Here the distances are so prodigious that much of the work of any

society must be done in local sections if it is to progress rapidly. London however, is unique in its availability as a centre, and can draw in for any given cause a larger proportion of the total activity of the country than any other city in the world, Paris, perhaps, excepted. It is in many respects an ideal city for the organization of a technical body, despite its immense area. If the British Illuminating Engineering Society makes the most of its opportunities it will be able to command a respect and find a field of usefulness that will be altogether gratifying. But all this means a deal of hard work. In some respects nothing is more trying than conducting a campaign of education. As it drags its course along it seems that very little progress is being made, and it is sometimes a long time before results begin to show. Then, fortunately, they often develop with astonishing rapidity. Such has been the case with illuminating engineering in this country, and such will doubtless be the experience of our British friends. The chief thing is to keep at it persistently, never getting disheartened at things that are temporarily going wrong. When the ultimate purpose of the work is to benefit the public, the public will before long find it out and respond. Thus we give greeting to the new society, and wish it prosperity from the start and increasing success as it goes along and does its work. There is need for its work, which is the very best augury for a bright future.

An Ingenious Swindle.

From time to time instances come to light of cases in which the consumer who wishes to avail himself of the metallic filament lamp is victimized by irresponsible and dishonest persons. The latest example is described in a recent number of *The Electric Times*.

It appears that the shopkeeper, who is probably aware of the economy which may be derived from Metallic Filament Lamps, and is favourably disposed to reduce his lighting bill, is approached by a traveller who introduces to his notice an apparently new and very efficient lamp of small size. He points out that it will stand vibration, burns at any angle, gives several times the light of those already in use, and is yet obtainable at a very much cheaper price than the ordinary metallic filament lamps. Possibly he may demonstrate this with a small portable ammeter, and the unsuspicious shopkeeper probably closes with the offer and purchases a supply.

As soon as the lamps are handed over, and the cash parted with, the seller vanishes, and is seen no more. The "metallic" filament lamps thus installed may continue to give a brilliant and economical light for several hours, but presently the bulbs blacken and, finally, they burn out, probably blowing some of the fuses as the same time.

Upon examination, the lamps turn out to have very ordinary carbon filaments, their high initial candle-power and comparatively low consumption being due to excessive over-running. For 200 volt circuits, lamps of 150 volts are used, and for low pressures those intended for correspondingly lower voltages. In order that the difference in the shape and length of filament may not be noticed by a keen buyer, the bulbs are usually frosted, while, needless to say, neither the voltage, candle-power, nor makers' name, appear on the bulbs or the packing.

The prevalence of frauds of this type is also commented upon in a recent number of *The Ironmonger's Chronicle.*

To such an extent, it is stated, has this sale or peddling of poor-quality lamps been carried on in London and the large provincial towns that the president of the Associated Municipal Electrical Engineers (Greater London) has issued a statement that lamps reported to be of the metallic filament type of best quality are being offered for sale at high prices, and that these lamps are actually of inferior quality and quite unsuitable for the purpose for which they are sold. He warns electric light users against purchasing lamps which are sold by unknown dealers, and which do not bear the makers' name, and states specifically that the purchase of lamps in the manner indicated can only result in disappointment and increased electric lighting bills. Users are recommended in the statement to avail themselves of the advice, which will be freely given without cost to the consumer, of the chief electrical engineer of the district from which they obtain the supply of current.

Naturally, retailers who have but little technical knowledge of lamps fall easy victims to such deceptions, and have small possibility of redress.

The solution of the difficulty would seem to be facilitated by the adoption of a recognized guarantee-mark to be attached to lamps in order that action may be taken should lamps be sold which do not come up to the requirements marked thereon. This point has previously been emphasized in *The Illuminating Engineer,*

CORRESPONDENCE.

Visual Acuity and Light of Different Colours.

Dear Sir,—Mr. J. S. Dow, in his interesting communication to the April number of *The Illuminating Engineer*, comes to the conclusion that green light is more effectual as regards visual acuity than red light. He seems to see in this conclusion a contradiction of the remarks made by myself in the year 1884, and I therefore take this opportunity of referring to this question.

My remarks on that occasion were merely intended to convey that, in general, two surfaces different in colour but equivalent as regards brightness, were not equivalent as regards visual acuity. I left the question undecided which of the two surfaces was most favourable to visual acuity, since my experiments at that time had not been sufficiently extended to justify me in making a rigid assertion on this point.

It is true that on this occasion I substantiated my contentions by reference to the work of Macé de Lépinay, and his belief that red light was of greater consequence from the standpoint of visual acuity than that from the more refrangible part of the spectrum, and I added the words, " . . . .according to Macé de Lépinay the refrangible rays from green onwards contribute but little to the detail-revealing power of an illuminant, but are of considerable value for the purpose of producing surface-brightness."

If this statement is correct it is clear that a fundamental difference between photometric methods based upon the brightness of surfaces, and those involving acuteness of vision, exists. This was the only point I desired to emphasize on the occasion referred to.

Probably this conclusion of Macé de Lépinay is still correct to-day. It must be borne in mind that in this case only those rays existing between the middle of the green and the violet were specified. It is therefore very possible that this remark does not apply to green rays of the character which Mr. Dow has in mind. In fact it is only necessary to suppose that the maximum visual acuity occurs in the green in order to reconcile the apparent discrepancy between the experiments of Mr. Dow and those of Macé de Lépinay. In any case credit must be extended to Mr. Dow for attacking a problem which is of great consequence in the interests of photometry.

A complete investigation of the very complex conditions which have to be borne in mind in studying this problem would carry me too far afield. I may, however, briefly describe in what follows some further experiments in this connexion.

Dr. I. Stuhr, who, at my recommendation, has been studying the question of visual acuity at this University, has published the following results in his recent dissertation on ' The Determination of the equivalent values of lights of different colours by the methods Surface-brightness, Visual Acuity, and Flicker " :—

1. In order to measure the intensity of a source of light which differs considerably in colour from that of the standard in which it is expressed, it has proved convenient to determine the intensity by means of any ordinary photometer (for instance, that designed by myself), the field of view being, however, observed through red glass. Let this intensity be denoted by I. The equivalent value of the source, B, can then be obtained by multiplying by a suitable factor, k, such that $B=k.\ I$. The factor k is determined by special previous investigation. It has, however, essentially different values according as the methods of visual acuity, brightness of surface, or flicker respectively, are the basis of judgment. Further, k varies according to the particular colour of the source studied and the special variety of red

glass used. When these two factors are constant measurement may be carried out merely by the easy and convenient observation of I_r.

Numerous experiments had already been carried out by myself in 1884 with the object of determining k for the glowlamps yielding light of a more or less white character, and also for daylight. In addition to the red glass, used as directed above, a suitable green glass was employed, and a corresponding relation between the two sources compared under these conditions deduced. The ratio, $\frac{G}{R}$ (*i.e.*, the ratio of the intensity in the green to the intensity in the red referred to the standard candle), increases as the temperature of incandescence rises, and furnishes an indication of the colour. Thus each value of $\frac{G}{R}$ corresponds to a special value of k, and a table could be constructed connecting these values. The following are a few selected figures illustrating this connexion :—

$\frac{G}{R}$,	0·5	1·0	1·5	2·0	25	3·0
k,	0·64	1·00	1·34	1·60	1·84	2.02

These tables, it may be stated, were initially compiled purely in connexion with visual acuity.

The question arose whether this table was also applicable to other sources of lights—for example, the incandescent mantle. Dr. Stuhr has now applied the same method to the incandescent mantle, and has found that the values of k so determined, though somewhat greater than the previous values obtained by me, on the whole agree with them very well. For instance, as the mean of a series of observations on the mantle he finds k to have the value 1·84 instead of 1·72, corresponding to the ratio $\frac{G}{R}=2{\cdot}24$. The higher values of Dr. Stuhr can be explained by the fact that, in my earlier determinations of visual acuity, an illumination of 1·26 Meterkerze (Spermaceti candle) or 1·41 Meterkerze (Hefner) was employed, while Dr. Stuhr used illuminations of 4 to 13 MK (Hefner). The value of k is thus dependent upon the order of illumination employed becoming greater with increasing intensity.

2. In this connexion it should be stated that Dr. Stuhr has found that for illuminations from 4 to 8 MK (Hefner) k had a value of 1·67 (for the mantle), but for illuminations from 8 to 13 MK (Hefner) a value of 1·84. It appears, therefore, that any comparison of the intensity of heterochromatic sources of light on this basis must be made at a specified illumination ; for this purpose an intensity of 10 Meterkerzen (Hefner) was utilized. It might be suggested that the increase in the value of k with increasing illumination is connected with the Purkinje effect, because this naturally affects not only surface-brightness but also visual acuity. However, Macé de Lépinay has found that the Purkinje effect only becomes marked when one of the sources contains rays that are *less* refrangible than the green and the other rays that are *more* so, and is not perceptible when both the qualities of light compared lie within the red and the green. One would, therefore, suppose that the Purkinje effect would not become noticeable in the case of a comparison between the incandescent mantle and the candle. Actually, however, in order to explain Stuhr's results, it would seem to be necessary to suppose a reversal of the Purkinje effect to be taking place ; for, with increasing illumination, the incandescent mantle, which is rich in refrangible rays, apparently contributes to a smaller degree to visual acuity than the less refrangible light from the candle. In any case such an experience demands further investigation.

3. Dr. Stuhr has also compared the values of k on the basis of surface-brightness and flicker. In both cases the values of k are less than those obtained by the method of acuteness of vision. The values obtained by the surface-brightness method fall third on the list. Thus k, by the visual acuity methods, is 21·17 per cent higher than by the surface-brightness method, for the incandescent mantle, and 23.22 per cent higher in the case of daylight. The corresponding figures for the flicker

method are 13·26 per cent and 17·17 per cent respectively.

The conclusions to be drawn from these results, in so far as concerns the incandescent mantle and daylight, are in accordance with the suggestion of Mr. Dow, namely, that the refrangible rays contribute to a greater degree to visual acuity than the less refrangible. There appears to be a possible explanation of the reason for the conflicting result recorded by Macé de Lépinay, namely, the fact that the latter's experiments were carried out at very low orders of illumination (under 0·5 MK), and, in addition, with pure spectral colours. Further experiments in this direction seem very necessary.

4. Dr. Stuhr has also undertaken a special study of flicker phenomena, carried out with the Krüss and Franz, Schmidt, and Haensch photometers. He comes to the conclusion that the use of a flicker photometer for comparing spectral colours may lead to results differing more or less from those obtained by the aid of the ordinary direct surface-brightness method, and this deviation becomes greater according as the tints compared are further apart from each other in their spectral order. Simultaneously the sensitiveness of the method is diminished.

If one admits the justice of Siemens's principle that the determination of the illumination in factories, &c., ought to be carried out on the basis of visual acuity, it is of interest to remark that the flicker-photometer will yield results differing considerably from those obtained on this basis, but still not so greatly as would be the case for measurements on the surface-brightness method. These considerations, however, do not lead one to regard the application of flicker photometry in practice as very hopeful.

In conclusion, let me add a few remarks upon the application of these experiments of Dr. Stuhr and myself to practical photometry.

Each of the three methods of comparing heterochromatic sources of light —the methods of visual acuity, surface-brightness and flicker—leads to a series of fundamental difficulties, quite apart from the uncertainties connected with the actual process of observation, when any attempt is made to express the intensity of such sources in exact terms. The direct application of these methods to the comparison of the sources of light used in practice is therefore extremely undesirable. For practical measurements of this kind there remains only the method of using an ordinary photometer, in connexion with suitable screening coloured glasses, and the subsequent multiplication of results so obtained by a predetermined factor k. This factor is obtained by an exact series of researches, taking account of all the circumstances referred to above. From such researches tables can be constructed, similar to those worked out by Dr. Stuhr and myself, giving values of k which can be utilized in connexion with the methods of visual acuity, surface-brightness and flicker respectively.

I am, yours sincerely,

PROF. DR. L. WEBER.

Kgl. Universität zu Kiel.

The Internal Lighting of Churches.

SIR,—I have read the further communication of your correspondent in the April number of *The Illuminating Engineer*, but I must confess that I find little therein to induce me to modify the view previously expressed.

It is, of course, interesting to learn the nature of the illumination employed in the Temple of Herodes or the Cathedral of Lhasa, but surely the suggestion cannot be entertained that we should base our modern systems of illuminating churches solely on such examples as these. The illumination in ancient times would, quite naturally, be very dim—simply because the methods of

producing and distributing light were so primitive. But it is surely unreasonable to ask us to refrain from employing the vastly improved facilities of the present day because they were not available to our remote ancestors! Of course, in the case of cathedrals and religious edifices of very ancient date and great historic interest, it may be justifiable to retain the original system of illumination, exactly as it was used by worshippers in ancient times, merely to enable us to picture the interesting old conditions more perfectly. But in such a case we are considering the building more in the light of its historical value than from the point of view of religious worship.

When we come to consider the religious aspects of the matter, probably all that can be said with certainty is that the conditions preferred by different sects and denominations will vary very greatly, and it is impossible to lay down any hard and fast rules. In any case it hardly seems probable that even religious feelings regarding illumination would be satisfied by the identical conditions evolved two thousand or more years ago.

Moreover, many forms of service, such as that practised in the Church of England, for example, can only be entered into fully by many members of the congregation when they are able to follow in the Prayer-book, Bible, or hymn-book, and adequate illumination must somehow be provided to enable them to do so. In the case of churches of modern date these conditions are often of paramount importance and æsthetic and historic considerations quite secondary.

It seems questionable whether people of to-day have any desire for the gloomy surroundings which were borne philosophically in the past. Restraint in lighting and taste must, of course, be exercised; but, now that the introduction of modern illuminants into churches is becoming more and more general, it is all the more essential that those responsible should consider how far the grafting of the new on to the old is desirable and the best means of making use of the privileges which modern systems of illumination provide.

I am, yours truly,

AN ENGINEERING CORRESPONDENT.

FIG. 2.—Excello Deposit-Free Globe.
Appearance of ordinary and deposit-free cover after 100 hours burning.

TRADE NOTES.

[At the request of many of our readers we are extending the space devoted to Trade Notes, and are open to receive for publication particulars of new developments in lamps, fixtures, and all kinds of apparatus connected with illumination.

The contents of these pages, in which is included information supplied by the makers, will, it is hoped, serve as a guide to recent commercial developments, and we welcome the receipt of all *bona fide* information relating thereto.]

Deposit-Free Covers for Excello Arc-Lamps.

From the **Union Electric Co., Ltd.,** we receive particulars of the recently introduced deposit-free cover which, it is claimed, avoids the gradual formation of an absorbing film on the interior of the globe owing to the fumes from flame-carbons—a long-standing difficulty in connexion with flame arc-lamps.

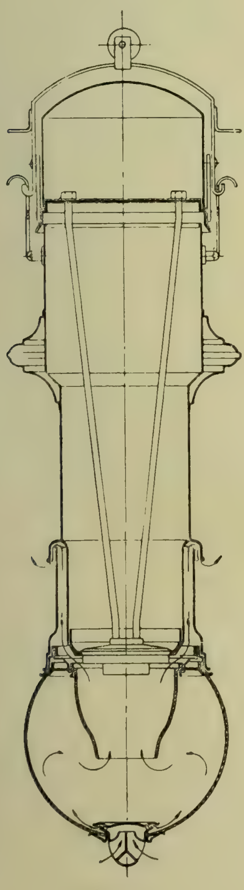


Fig. 1.

The general nature of the innovation will be understood from Fig. 1.

It will be seen that fresh air passes through the special form of ventilating ash tray and evenly sweeps the inner surface of the globe with clean air, which then passes into the inner globe at considerable speed, also keeping this free from deposit, while it finally makes its exit near the upper edge of the inner globe into the annular space between the two sections of the cover; due to the large area and the lower temperature, the products of combustion are deposited here, and are thus easily removable by means of a cloth or brush, the cover being made to easily separate for this purpose.

As a result, it is stated, the globe retains its original translucent qualities very well, its appearance after 100 hours' burning as compared with that of an ordinary lamp being shown in Fig. 2 on the opposite page.

Messrs. The Union Electric Co. inform us that their exhibit of arc-lamps and motors at the recent Sheffield Smoke Abatement Exhibition was awarded the first-class diploma for trade and municipal appliances.

Messrs. J. G. Childs & Co., Ltd., send us a description of their Wind Turbines and Electrical Equipment, to give from one-third to 150 h.p., and the provision of light and power in connexion with country houses, lighthouses, &c., and other isolated positions where electrical or gas power is not available.

One interesting application described is the erection of a wind plant for the working of lifts at country railway stations.

We have also to acknowledge the receipt of several publications of the **British Thomson-Houston Co., Ltd.,** relating to the B.T.H. tungsten lamps and small auto-transformers for use therewith.

Messrs. Julius Sax & Co., Ltd., send us up-to-date particulars of adapters of various kinds for metallic filament lamps, pendant fittings for Holophane reflecting bowls and spheres, &c.

Electric Light Fittings on Board Ship.

WE have received from **Messrs. Siemens Brothers'** Dynamo Works, Limited, Tyssen Street, Dalston, N.E., a new Catalogue dealing with "TANTALUM" lamps and fittings, specially designed for SHIP AND HARBOUR LIGHTING, which contains a varied selection of fittings. The list also deals with metal and carbon filament lamps of convenient voltage and candle-power. One point to which attention is drawn is the value of lamps able to withstand vibration and capable of burning in any position on board ship. In addition, the use of metallic filament high efficiency lamps enables the available light to be considerably increased without overloading existing plant, or, in the case of a new ship under construction, the plant installed to be of smaller capacity than would be necessary for carbon filament lamps.

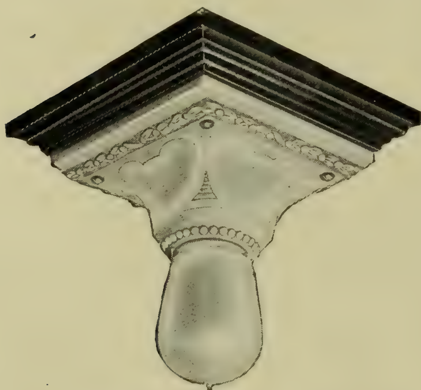


FIG. 1.—"Majolica" Fitting for Ship Lighting.

FIG. 2.—Type of "Majolica" Fitting for Ship Lighting.

High Voltage Tantalum Lamps.

Messrs. Siemens Brothers also announce that they are now able to supply "Tantalum" lamps for 200–250 volt in 32 and 50 candle-power. In general appearance these lamps closely resemble "Tantalum" lamps of lower voltage, except that they contain two filaments wound upon two sets of supporting arms instead of one only. We have received a circular containing particulars of the new lamps, together with details concerning "Tantalum" candle-lamps. The latter are supplied with plain candle-shaped bulbs for use in candle fittings, with small bayonet or small Edison screw caps for 24–40 volts, 5 or 10 candle-power. We understand that copies of these lists will be supplied to any *bona fide* applicant.

We have also to acknowledge the receipt of the new fittings catalogue of the same firm, which includes a number of novel designs, particularly a comprehensive list of combined Holophane and Tantalum lamp fixtures.

A New High Efficiency Nernst Lamp.

The Electrical Co., Ltd., inform us that they are placing on the market an improved form of lamp on the Nernst principle. The lamp is of small design, and the four parts of the original Nernst lamp, namely the body, burner, resistance, and globe are combined.

The 220 volt lamp is stated to yield 30 candle-power, and to consume about 0·2 amperes, the efficiency being thus about 1·4 watts per candle. Improvements in manufacture enable the lamp to light up approximately 10 seconds after switching on the current, and the life of individual lamps under normal conditions is stated to be not less than 400 hours, the average life of a burner being, however, estimated at about 700 hours. Lamps burning out under the specific period of 400 hours will be replaced free of charge.

The lamp is manufactured for all voltages from 200 to 300, but for the present only recommended for use on D.C. circuits. The list price is fixed at 2*s.* 6*d.*

Messrs. Joseph Baker & Sons, Ltd., (Willesden), send us particulars of the "Pierson" patent automatic gas-producer for power or heating purposes.

To **Messrs. Kirchner & Co.** (21–25, Tabernacle Street, E.C.) we are indebted for a catalogue relating to wood-working machinery of all kinds.

The Machine Gas Syndicate, who are exhibiting at the Building Exhibition at Olympia, send us copies of pamphlets giving the latest particulars of Cox's Air-Gas System for country house lighting, including a list of installations in different parts of the country.

Yet another publication referring to the lighting of country houses received is that of the **Wallsall Electrical Co., Ltd.,** who supply complete gas or petrol-driven electric lighting sets for country mansions, &c.

Low Candle-Power Metallik Lamps.

Information has just reached us that **Messrs. G. M. Boddy & Co.** (15, Gray's Inn Road, London) are placing on the market "Metallik" 16-candle-power low voltage (100 to 135 volts) and 32-candle-power high voltage (200 to 260 volts) metallic filament lamps.

We understand that orders for early delivery of these lamps are now being booked, the prices being 3*s.* and 4*s.* 9*d* respectively, subject to the usual discount.

The Kandem Arc Lamp Coupling.

Fig. 1.

We have received from **The UNION ELECTRIC Co., Ltd.**, an account of the "**Kandem**" Arc Lamp Coupling which, it is claimed, enables a lamp to be raised or lowered without the loose wires, winches, or other gear being required.

The operation of the coupling is as follows:—

The Lamp when in use is connected to a coupling and to a chain which engages into a locking stop as shown in Fig. 1. To lower the Lamp the trimmer hangs a strap on to the chain by means of a light rod as shown in Fig. 2. The Lamp can then, by pulling the strap which frees the stop, be lowered to a convenient distance from the floor and there locked by the lowering strap as shown in Fig. 3. A safety catch is provided which prevents the Lamp from falling, even if the lowering strap is let go by accident. After trimming, the Lamp is raised again by the strap, which is then removed and used for any other lamp.

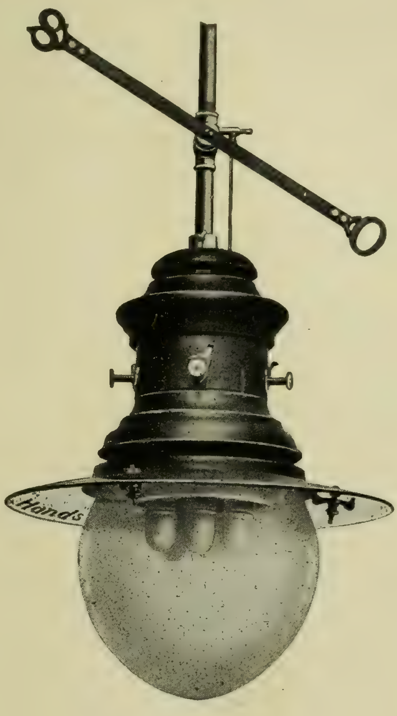
From the same company we have also received a list of the **FORTITER** resistance apparatus.

Fig. 2.

Fig. 3.

The New "Hands" Outside Lamp.

Our attention has been drawn to a new incandescent inverted gas lamp, introduced by **Messrs. G. Hands & Co.** (Farringdon Road, London, E.C.), and intended mainly for outdoor lighting. The general appearance of the lamp, which is made with either two, three, or five burners, will be gathered from the figure.



Although several mantles are used, however, it seems that it is not necessary to have a separate pilot flame for each burner burning continuously. In this case a main pilot flame is kept burning, and the pilots for the individual lights are only lighted up at the instant the main tap is turned on; as soon as the lamp is ignited they are automatically extinguished, and the consumer therefore only burns the amount of gas needed to keep the main pilot-flame alight.

For this lamp a light of 135 candles for each 3 cubic feet per hour burner is claimed. In addition all parts are readily accessible and interchangeable, and arrangements are made enabling the main body of the lamp to be disconnected and removed for the more elaborate repairs, should this be necessary.

Some Publications Recently Received.

Jahresbericht über die Fortschritte des Beleuchtungswesens in den Jahren, 1906 *und* 1907. By Dr. H. Strache. (Reprint from the *Chemiker Zeitung.*)—The reprint sent us by Dr. Strache is a complete and useful résumé of literature that has appeared, during the years 1906 and 1907, connected with illumination. It is accompanied by full references to the numerous sources quoted, and should prove of great convenience to those wishing to keep in touch with continental work on this subject.

Ueber die Bestimmung des Aequivalenzwertes verschiedenfarbiger Lichtquellen nach der Methode der Flächenhelligkeit, Sehscharfe und Flimmerphotometrie, by Dr. J. Stuhr. (At the University of Kiel.)—A dissertation on the relative values of the photometric methods of equality, of brightness, acuteness of vision, and flicker.

The Annual Report of the National Physical Laboratory.—The report contains a brief résumé of the photometrical work carried out at the laboratory during the year.

Verwaltungs-Bericht des Deutschen Museums zu Münich.—This annual report devoted to industrial and technical processes at Munich refers to the general progress of the work in its fifth year of existence. An interesting feature in this museum is the existence of a section devoted to exhibits connected with illumination.

Bulletin of the New York Public Library. Also the published list of works relating to illumination therein.

Engineering Wonders of the World.—Part I.—A new magazine designed to bring before the general public the importance and interest of modern engineering achievements. The first number before us is very fully illustrated by photographs descriptive of engineering work in different parts of the world. One article of interest is that by the editor, describing some of the engineering wonders of ancient times, such as the pyramids of Egypt, and the immense stone circles and pillars erected at Stonehenge, in Brittany, and elsewhere.

Other contributions deal with achievements of a more modern, but perhaps equally impressive character, such as the White Pass and Yukon Railway, the salving of a battleship, &c.

Illumination, a new monthly publication devoted to the science and art of illumination. The April number contains general articles dealing with gas lighting, acetylene, "lusol," and other illuminants from the popular standpoint. (The Illumination Publishing Co., Chicago, U.S.A.)

Fortschritte der Chemie, Physik und Physikalischen Chemie. Vol. I. Edited by Hermann Grossmann. (Gebr. Borntraeger., 9, Grossbeerenstrasse, Berlin S.W. II.) —Under the above title the first number of the new edition of the *Physikalisch-Chemisches Centalblatte* made its appearance on April 1st. In future this publication, dealing with recent developments in chemical and physico-chemical science, will appear monthly, and its scope of treatment will be extended. The subscription for the annual volume is 16 Mk.

Revue de la Soudure Autogène.—A new monthly publication, edited by MM. R. Granjon and Pierre Rosemberg, and dealing, in a popular fashion, with oxy-acetylene welding, and allied matters. (25 centimes a copy, 2 francs per annum. Publishing office, 104, Boulevard de Clichy, Paris.)

Ueber scharfe Röntgenogramme und über Schnellaufnahmen, by Dr. J. Rosenthal, and other papers by the same author. (Reprinted by the Polyphos Elek. Ges. of Münich.)

Petrol Air-Gas, by Henry O'Connor (Crosby, Lockwood & Son).

Berechnung und Konstruktion elektrischer Schaltapparate, by Prof. R. Edler. (Hannover, Dr. Max Janecke.)—A treatise on up-to-date switch gear of all kinds.

Illuminating the Editorial Offices of the New York World, by A. J. Marshall.—*The Mathematical Theory of Finite Surface Light Sources*, by Basset Jones, jun.—Papers recently presented at the New York section of the Illuminating Engineering Society.

The Artificial Lighting of Buildings with Electric Light, by J. Wallis Jones.—Paper read before the Architectural Association, December, 1907.

Office Lighting, by A. J. Marshall. (Building Management, April, 1909.)

As we go to press we receive a copy of the volume of the *Proceedings of the American Gas Institute* for the past year. The volume contains a series of valuable and interesting papers dealing with photometry, calorimetry, and gas-lighting generally, to which we hope to refer in greater detail on another occasion.

We have also to acknowledge with thanks the recent receipt of *Transactions* of the following societies during the past month :—*American Academy of Arts and Sciences, American Electro-Chemical Society, American Institution of Electrical Engineers, American Philosophical Society, American Illuminating Engineering Society, Atti della Associazone Ellettrotecnica Italiana, Bulletin of the Bureau of Standards, Institution of Civil Engineers, Archives de Musee Teyler* (*Haarlem*), *Western Society of Engineers, &c.*

Review of the Technical Press.

ILLUMINATION.

THE formation of the BRITISH ILLUMINATING ENGINEERING SOCIETY has given rise to considerable discussion in this country and in the United States. A recent editorial in *The Electrical World* of New York expresses sympathy with the movement, and states the conviction that any initial difficulties experienced will ultimately give way in this country, as had already been the experience in the United States. The intention of making the Society not a "Society of Illuminating Engineers," but an "Illuminating Engineering Society," is spoken of with approval, and it is suggested, further, that any unjustified use of the title of "Illuminating Engineer" should be discouraged by the Society.

Two recent editorials in *The Journal of Gas Lighting* comment upon the same matter. Here again sympathy is expressed with the aims and objects of the Society, but some doubt is expressed as to the time that must elapse before the illuminating engineer, in the strict sense of the term, can be developed.

The March number of the American *Illuminating Engineer* passes in review the PROGRESS OF THE PAST YEAR, and contains an article by the editor, **E. L. Elliott,** on the subject. In addition, the views of a number of well-known electrical and gas engineers are published regarding the directions in which most progress has been made.

Another paper by E. L. Elliott before the Illuminating Engineering Society has the title of SOME UNSETTLED QUESTIONS IN ILLUMINATING ENGINEERING. First among these again Mr. Elliott placed the query, "What is an illuminating engineer?" There are, however, many problems on which further information is wanted, such as the merits and otherwise of indirect lighting, and the physiological effects of different qualities of coloured light.

A recent contribution by **J. R. Cravath** deals with the vexed question of INDIRECT LIGHTING. There seems to be a general agreement that such systems are most effective when the light is thrown upon the ceiling, and that the bright illumination of side walls which are of a light tint is objectionable from the physiological standpoint. The most perfect conditions, Mr. Cravath suggests, will, in many cases, be met by the use of a relatively low general illumination, obtained from indirect lighting, coupled with concentrated local lighting at points where it is needed for special purposes.

There are also a number of papers by **A. J. Marshall, W. C. Allen, W. Basset Jones,** and others, which have recently been read before the Illuminating Engineering Society, and deserve further study. The contribution of **W. C. Allen** on STREET LIGHTING contains details of the lighting in various Continental and American cities, and is well illustrated; it deals, however, exclusively with electric light.

Mention must be made of a recent paper by **R. Edler** on the GRAPHICAL WORKING OUT OF HORIZONTAL ILLUMINATION, from a source having a known polar curve of light-distribution, at a given height above the pavement.

Some interest attaches to the interview, published in the recent number of *The Gas World*, with one of the Committee who have recently visited the Continent with the object of studying CONTINENTAL METHODS OF STREET LIGHTING and considering their application to the streets of London. A full report of the matter will be presented in due course, but no decision has been published as yet.

There are also a number of short contributions dealing with items of particular interest. In *The American Gas Light Journal* some particulars are given of CURIOUS TYPES OF LAMP SHADES, and devices for illuminating clocks, &c., which seem to be finding vogue in the United States. The March number of the American *Illuminating Engineer* also contains some critical comments on lamp-posts for street lighting.

PHOTOMETRY.

Among the contributions of the past month dealing strictly with photometry reference must be made to that of **Ulbricht** (*E.T.Z.*, April 8). He discusses the DETERMINATION OF THE "CENTRE OF RADIATION" of a source of light, and describes a special piece of apparatus used for this purpose; this apparatus, he mentions, was previously referred to by Dr. M. Corsepius in an article in *The Illuminating Engineer* (vol. i. p. 801) dealing with the globe photometer.

Several communications deal with the SIMPLE TESTING OF GLOWLAMPS. **Wahlers** (*Elek. Anz.*, April 15) comes to the conclusion that it is unnecessary to use a watt-meter or combined ammeter and voltmeter for this purpose, as the accuracy is not improved thereby, and a simple ammeter suffices.

Ives (*Elek. World*, March 25) describes an instrument for enabling the watts per candle-power of a glowlamp to be determined direct, and simultaneously the actual voltage at which this result is obtained registered.

Harwood (*Electrician*, April 16) suggests the modification of the Violle STANDARD OF LIGHT. This consists of an electrically heated platinum strip, which is brought to a specified temperature of incandescence determined by a special method involving the balancing of the radiation from the lamp after transmission through a plate of black fluorspar and a vessel of water respectively.

J. Stuhr has recently published the results of a series of researches, studying the PHOTOMETRIC METHODS OF EQUALITY OF BRIGHTNESS, VISUAL ACUITY, AND FLICKER as the means of comparing illuminants of differing colour. He finds that the results of these three methods differ considerably, and extends the Weber method of viewing the field of view of the photometer through red and green glass, which he considers preferable to either of the three above methods.

Among other communications mention should be made of the recently issued REPORT OF THE NATIONAL PHYSICAL LABORATORY, which contains some details of the most recent additions of photometrical apparatus, and the work carried out in the Laboratory during the past year.

ELECTRIC LIGHTING.

As usual a considerable number of communications appear in the United States dealing with TUNGSTEN LAMPS, the policy of central stations, and in particular the question of FREE RENEWALS. Articles by **H. J. Gille** (*Elec. World*, April 1) and others deal with the application of the Tungsten lamp to street lighting.

Loring contributes an article dealing generally with the qualities and manufacture of different types of incandescent lamps. The paper contains a complete table giving the relative costs of different systems of lighting corresponding with certain costs per unit, and some figures regarding the intrinsic brilliancy of various filaments.

An interesting article by **Schmidt** (*E.T.Z.*, April 25) describes the conditions under which CENTRAL STATIONS labour in RUSSIA. He states that towns in that country are usually spread over a more extensive area, and that oil-lamps are frequently used for street lighting; these he thinks can be more economically replaced by metallic filament lamps.

Two articles by **Meyer** and **Reiff** deal with the application of a NEW VARIETY OF PUMP and a TYPE OF VACUUM-METER respectively to the technicalities of glowlamp manufacture.

Special mention should be made of the annual résumé of RECENT PATENTS ON ELECTRIC LAMPS of all kinds which appears in *Elektrotechnik und Maschinenbau*. Many interesting processes are described, for some of which very great results are reported. For instance, one company describes a method by the aid of which it is claimed, filaments are obtained which will burn at 0·5 watts per H.K., without any appreciable loss in candle-power, and without being enclosed in a vacuum; in addition the specific resistance of filaments so manufactured is stated to be very high.

Monasch (*E.T.Z.*, April) contributes a general review of the PROGRESS IN ARC LAMPS. He describes the new Blondel cored carbons which yield a flame arc but can be burnt in a vertical position one above the other.

GAS, OIL, ACETYLENE, &c.

One event of considerable interest in the gas world during the last month has been the *adoption of a calorific test*, together with a reduction in illuminating value of 16 to 14 candle-power, by the Gas Light and Coke Co. This seems to be another indication of the gradual transition from illuminating to calorific value, which many engineers consider probable.

An editorial note in *The Jonrnal of Gas Lighting* comments upon LANTERN-DESIGN. It is pointed out that many of the lanterns in common use are somewhat out of date. What usually happens is that a new type of lamp is installed in an already existing lantern, irrespective of the question whether it is adapted thereto or not. Now that inverted street lamps are becoming usual there is an opening for a new form of lantern, specially designed for this form of burner. In addition, when it is recalled what prominent objects in the daytime many lanterns and lamp-posts are, the importance of designing them in good taste will be admitted.

The question of the DESIGN OF GAS-FIXTURES is one that seems to be the subject of much consideration in the United States; several of the representa-

tives of gas-lighting writing in the last number of the American *Illuminating Engineer* refer to this matter. It seems to be recognized by those in that country that many of the fixtures are not designed on suitable lines, either from the standpoint of illumination or as artistic objects. Gas, indeed, is felt to have fallen behind the latest electrical designs in this respect, but the industry are now making efforts to make up their lee-way. A recent lecture by **H. Dodimead** deals with STREET LIGHTING and attention to the CLEANLINESS OF LANTERNS, &c., and contains much practical and interesting advice as to the maintenance of street lamps.

Several recent contributions by **T. J. Litle** deal generally with gas lighting and the application of the principles of illuminating engineering thereto. The communication of this author to the March number of the *Transactions* of the Illuminating Engineering Society deals specially with the correct placing of such lamps for shop lighting, the illumination of halls, &c., and is illustrated by several clear and telling diagrams. **A. C. Morison,** in the March number of the American *Illuminating Engineer,* and elsewhere, deals with the present state of acetylene lighting in a similar manner.

Two recent contributions to *The Journal für Gasbeleuchtung* deserve special mention. **Meyer** contributes a very complete paper dealing with METHODS OF AUTOMATIC CONTROL BY WAVES OF GAS-PRESSURE. He lays down twelve conditions with which such devices ought to comply, and shows a series of graphs of pressure rise and fall illustrating the action of the Bamag and Rostin apparatus. A similar article by Wendt in the same journal deals with electrical systems of automatic control.

As usual some particulars of recent types of inverted burners, &c., have appeared in *The Zeitschrift für Beleuchtungswesen ;* the same journal contains a continuation of the article entitled ' Luft-Gas and Acetylene,' in which the non-condensible qualities of good grades of air-gas, even under severe atmospheric conditions, are insisted upon.

MISCELLANEOUS.

Under this heading special reference must be made to a treatise by **W. Coblentz,** which was published in the February number of *The Bulletin of the Bureau of Standards.* The author describes a series of experiments upon various incandescent bodies, including the different types of filaments of electric lamps, which are of the highest importance from the theoretical standpoint. He traces the curves of energy distribution in the spectrum of the light yielded by Tungsten, Helion, and other filaments, which are found to differ essentially. One of the most interesting results by which he seeks to explain the improved efficiency of the metallic filaments is that metals seem to have a high co-efficiency of reflection for infra-red energy but a relatively low value for visible light. Consequently, by Kirchoff's law, they are also correspondingly well adapted to emit radiation in the visible range, and badly adapted to emitting the useless infra-red energy.

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Cravath, J. R. The Use of Tungsten lamps from the Illuminating Engineering standpoint (*Elec. World*, N.Y., April).
Editorials. Elec. Lighting Development (*Elec. World*, N.Y., April 1).
Free Lamp Renewals (*Elec. World*, N.Y., April 1).
The Radiation of Electric Lamps (*Elec. World*, N.Y., April 8).
The Central Station and the Small Consumer (*Elec. Engineer*, April 23).
The Cost of Gas and Electric Candlepower (*Elec. Rev.*, N.Y., April 10).
Street Lighting in Europe (*Elec. Rev.*, N.Y., April 17).
Gille, H. J. Tungsten Lamp Street-Lighting Results (*Elec. World*, N.Y., April 1).
Guye and Bron, A. Spannungsabfall und Stabilität des Wechselstrombogens Zwischen Metallelektroden (*Z. f. B.*, April 10).
Loring, Geo. Tungsten and other Lamps (*Jour. of the Western Society of Engineers*, April, 1909).
Meyer, G. Die Anwendung der Gaedepumpe zur Fabrikation von Metallfadenlampen mit Experimenten und Demonstrationen (*E. T.Z.*, April 8).
Monasch, B. Fortschritte der Bogenlampentechnik (*E. T. Z.*, April 15, 22).
Schmidt, C. Ueber Zentralanlagen in russischen Städten (*E. T. Z.*, April 15).
Reiff, H. J. Das Kompressions- Vakuummeter in der Glühlampenfabrik (*Elek. Anz.*, April 22, 25).
Wolcot. Alternating Currents and their Application. III. Lighting (*Elec. Review*, N.Y., p. 570).
Fortschritte auf dem Gebiete des Elektrotechnik, (1) Glühlampen, (2) Bogenlampen, (3) Quecksilber Metalldampflampen (*Elek. u. Masch.*, April 11, 16).
The Electric Lighting of Steamships (*Elec. Magazine*, April).
The Chicago Electric Shop (*Elec. World*, N.Y., March 18).

GAS, OIL, AND ACETYLENE LIGHTING, &c.

Dodimead, H. Street Lighting (*G. W.*, March 27; *J. G. L.*, March 23).
Editorials. The Measure of Satisfactory Lighting (*G. W.*, April 3).
A Calorific Power Standard (*J. G. L.*, March 30; April).
The Reformation of the Street Lamp (*J. G. L.*, April 20).
Fulweiler. Theory of Flame and Incandescent Mantle Luminosity (*J. G. L.*, April 20, abstract).
Litle, T. J. Progress in Incandescent Lighting during the past Year (*Illuminating Engineer*, N.Y., March).
Specialized Gas Lighting (*T. I. E. S.*, March).
Meyer. Uber Gasdruck-Fernzündungen für Strasslaternen (*J. f. G.*, April 17).
Morrison, A. C. The Present Status of the Acetylene Industry (*Illuminating Engineer*, N.Y., March).
Illuminating the Country Home (*Acetylene*, April).
Wendt. Elektrische Gasfernzünder (*J. f. G.*, April 24).
Adoption of Calorific Test by Gas, Light and Coke Co. (*G. W.*, March; April 3).
The High Pressure Inverted Gas Lamps in Fleet Street (*J. G. L.*, April 6).
Demonstration Work by Gas Companies (*J. G. L.*, April 20).
Neue Invertbrenner (*Z. f. B.*, March 30).
Luftgas und Acetylen (*Z. f. B.*, April 20).

MISCELLANEOUS.

Coblentz, W. W. The Radiation Constants of Metals (*Bull. Bureau of Standards*, Feb., 1909).

CONTRACTIONS USED.

E. T. Z.—*Elektrotechnische Zeitschrift.*
Elek. Anz.—*Elektrotechnischer Anzeiger.*
G. W.—*Gas World.*
Illum. Eng., N.Y.—*Illuminating Engineer of New York.*
J. G. L.—*Journal of Gaslighting.*
J. f. G.—*Journal für Gasbeleuchtung und Wasserversorgung.*
Prog. Age.—*Progressive Age.*
Phys. Rev.—*Physical Review.*
T. I. E. S.—Transactions of the Illuminating Engineering Society.
Z. f. B.—*Zeitschrift für Beleuchtungswesen.*

REVIEWS OF BOOKS.

ELECTRIC LAMPS.

BY MAURICE SOLOMON.

Published by Constable & Co., Ltd., London, 6s. net.

WHILE dealing mainly with recent developments in electric lighting, the author very fitly devotes the first chapter of the book to the discussion of general principles of illumination, and gives the reader the benefit of some sound and simple advice as to the choice and use of illuminants for various purposes. The second chapter deals with the artificial production of light, and chaps. iii. and iv. with photometry and methods of testing. In these pages the author explains the fundamental photometrical quantities, and gives a brief account of the chief modern types of photometers.

Chaps. v., vi., and vii. deal with modern glow-lamps, and chaps. iii., ix., and x. with arc-lamps. Chap. xi. treats on methods of electric lighting not falling in these categories, including the mercury-vapour, Moore, and other systems, and chap. xii. is given up to a discussion of the merits of the different lamps considered.

It will be seen, therefore, that the author, in the 321 pages at his disposal, seeks to cover a very wide field. In so doing he wisely prefers to dwell upon principles rather than to attempt to treat processes of manufacture in great detail. For instance, the treatment of the methods of manufacturing tungsten filaments by the Just and Hanaman, Kuzel, and other methods—in itself a very vast subject—is necessarily compressed into a few pages.

At the same time the contents of the book furnish ample evidence of exceptional technical knowledge of the subject, and several sections, notably that devoted to the discussion of the Nernst lamp and the manufacture and testing of arc-lamp carbons, contain information that is not readily obtainable. The treatment of electric lamps is also quite up to date, reference being made to the properties of the Moore tube, the magnetite arc, and the Küch quartz-tube mercury vapour lamp, and the summary of the lighting situation in the last chapter is of considerable interest. Some useful and concise tables are provided comparing the cheapness of various electrical illuminants on the basis of different costs per unit of electric energy

In addition, it may be said that the book is throughout well-written, and we have no doubt that it will be found extremely useful by those interested in the subject of illumination.

GEOMETRICAL OPTICS.

BY VAL. H. MACKINNEY AND H. L. TAYLOR.

Published by J. & H. Taylor, Birmingham

THIS compact treatise on 'Geometrical Optics' is largely a new edition of certain sections of the 'Key to Sight-Testing.' The book contains a concise treatment of the elementary theory of lenses and their application to the amelioration of defective vision, a special feature being that the formulæ are based throughout on the "Curvature System" of notation.

The subject-matter of the volume is very compressed; the explanations are however, clearly expressed, and are facilitated by a liberal use of excellent illustrations, and this little book will probably be found very serviceable by many in the optical industry. One practical feature which deserves commendation is the addition of a series of references to works on optics and allied subjects, and also of a set of optical experiments. The list of useful articles for the benefit of those engaged in sight-testing, &c., and the prices at which they may be obtained, should also prove convenient to readers of this work.

A Correction.

OUR attention has been drawn to the description of the "Rostin" Automatic Lighting and Extinguishing Apparatus on p. 256 of the April number of *The Illuminating Engineer.* We are informed that the impression conveyed by the words in the second column, "an increase in pressure .... cock," is not strictly accurate, a preferable version being "a rise of pressure beyond the point to which the inlet valve is adjusted having the effect of admitting the gas to the working bell which turns on a main cock."

PATENT LIST.

COMPLETE SPECIFICATIONS ACCEPTED OR OPEN TO PUBLIC INSPECTION.

I.—ELECTRIC LIGHTING.

/4,922. Incandescent lamps. March 4, 1908. Accepted April 7, 1909. C. H. Steam and C. F. Topham, 47, Lincoln's Inn Fields, London.

/5,681. Electric light fittings. March 13, 1908. Accepted March 24, 1909. F. M. Long, 77, Chancery Lane, London.

/6,059. Suspension devices for electric lamps. March 18, 1908. Accepted March 24, 1909. R. Baron, 111, Hatton Garden, London.

644. Arc lamps. March 23, 1908. Accepted March 31, 1909. Crompton & Co., Ltd., and C. Crompton, Arc Works, Chelmsford.

7,593. Watertight holders for incandescent lamps. April 6, 1908. Accepted April 15, 1909. E. G. Byng, and C. E. Gunner, 71, Queen Victoria Street, London.

8,298. Choking coils for arc lamp (C.S.). April 14, 1908. Accepted April 15, 1909. L. O. Langworthy, 53, Chancery Lane, London.

8,308. } /9,862. } Arc lamps. April 14, 1908. Accepted April 7, 1909. W. J. Davy, 40, Chancery Lane, London. (Cognate applications.)

18,832. Arc lamps (C.S.). Sept. 8, 1908. Accepted March 31, 1909. H. Liske and A. Zöller, 18, Southampton Buildings, London.

1,316/09. Electrode for search lights (C.S.). I.C. April 9, 1908. Germany. Accepted April 15, 1909. Gebrüder Siemens & Co., Birkbeck Bank Chambers, London. Addition to 13,071/07.

7,471/09. Arc lamps (C.S.). I.C. March 28, 1908, Germany. H. J. J. Jaburg, 37, Furnival Street, High Holborn, London.

8,283/09. Regenerating blackened carbon filaments (C.S.). I.C. April 6, 1908, Germany. E. A. Krüger, 18, Southampton Buildings, London.

II.—GAS LIGHTING.

5,793. Lighting and extinguishing by varying pressure in mains. March 16, 1908. Accepted March 24, 1909. J. Rosie, and J. McKelvie, 37, West Nile Street, Glasgow.

6,790. Lighting appliances. March 27, 1908. Accepted April 7, 1909. T. Brown, 55, Market Street, Manchester.

7,221. Inverted incandescent burners. April 1, 1908. Accepted March 24, 1909. J. Webber, 18, Southampton Buildings, London.

7,791. Inverted incandescent burners and lamps. April 8, 1908. Accepted April 15, 1909. A. E. Podmore and J. Thomas, 256, Croxted Road, Herne Hill, London.

11,586. Igniting gas lamps by induced current (C.S.). May 18, 1908. Accepted April 7, 1909. C. Heinrichsdorff, 231, Strand, London.

12,278. Fittings for incandescent burners. June 5, 1908. Accepted March 24, 1909. J. Booth, trading as Samuel Booth & Co., and R. J. Simpson, 35, Temple Row, Birmingham.

17,321. Lighting incandescent street lamps, &c. Aug. 18, 1908. Accepted April 7, 1909. T. L. Cuttell and The Anti-Vibration Incandescent Lighting Co., Ltd., 33, Chancery Lane, London.

23,122. Incandescent mantles (C.S.). Oct. 30, 1908. Accepted April 15, 1909. L. Severin, 231, Strand, London.

28,560. Incandescent lamps (C.S.). Dec. 31, 1908. Accepted March 24, 1909. E. H. Still, 46, Lincoln's Inn Fields, London.

4,361/09. Incandescent lighting with Dowson gas (C.S.). I.C. March 12, 1908, Denmark. E. N. G. Ernst, 77, Chancery Lane, London.

5,117 09. Lighting and extinguishing burners at given hours (C.S.). I.C. March 18, 1909, France. E. de Gonnevitch, 111, Hatton Garden, London.

6,556/09. Incandescent mantles (C.S.). I.C. March 20, 1908, France. J. L. Muller, and J. Bonnet, 111, Hatton Garden, London.

6,963/09. Attaching incandescent mantles to mantle rings (C.S.). I.C. March 28, 1908, Germany Deutsche Gasglühlicht Akt.-Ges., (Anerges.), 1, Great James Street, Bedford Row, London.

III.—MISCELLANEOUS

(including lighting by unspecified means, and inventions of general applicability).

5,849. Intermittently illuminating signs, &c. March 16, 1908. Accepted March 24, 1909. H. M. Thomas, Birkbeck Bank Chambers, London.

9,008. Illuminated advertisements. April 25, 1908. Accepted March 24, 1909. A. Richardson, 116, Trewhitt Road, Heaton, Newcastle.

17,256. Petroleum incandescent lamps (C.S.). Aug. 17, 1908. Accepted April 15, 1909. O. Gronbladh, 36, Chancery Lane, London.

24,365. Starting devices for petroleum and like incandescent lamps (C.S.). Nov. 12, 1908 Accepted April 7, 1909. C. Hannemann, 18, Southampton Buildings, London.

7,069/09. Illuminated sign-lamps (C.S.). I.C. March 26, 1908, U.S.A. J. G. Saftig, 18, Southampton Buildings, London.

EXPLANATORY NOTES.

(C.S.) Application accompanied by a Complete Specification.

(I.C.) Date applied for under the International Convention, being the date of application in the country mentioned.

The ILLUMINATING ENGINEER

ELECTRICITY · ACETYLENE · OIL · GAS

Edited by LEON GASTER

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EDITORIAL.

The Proposed International Unit of Light.

IT is with very great satisfaction that we record the recently issued announcement of the National Physical Laboratory regarding the proposed international unit of light, and we hope that this proposal will soon receive definite international sanction.

Briefly the proposal recommends that the British and French units (at present fortunately in almost exact agreement), should be maintained at their present value, and, further, that the United States unit should be lowered 1·6 per cent in order to be also in equality. It is suggested that the value in use in Germany and in countries abiding by the Hefner standard shall be taken as the round figure 0·9 of the international unit. This is, of course, a very satisfactory simplification, and we may venture to hope that, in the future, there will only exist one single international unit, universally accepted; this, it may be pointed out, would be of great ultimate benefit to Germany, as the manufacturer and exporter of large numbers of glow-lamps and incandescent mantles.

We observe that the announcement has given rise to very general approval, and it is only fitting to describe the agreement as a triumph of the application of "illuminating engineering principles," which, carried out on the impartial international lines we have always recommended, and with a genuine desire to sink minor differences for the common good, met with deserved success. Under the circumstances we do not wish to emphasize unduly the good services of any particular country in this connexion. We feel, however, that a word of special commendation is due to the United States, whose representatives, in different fields, have worked so hard for this end, and who in consenting to lower their existing unit are making a certain concession for the common weal.

We should also like to draw our readers' attention specially to the extract from the newly issued report of the International Electrotechnical Commission which precedes the notification from the National Physical Laboratory. Any one who has followed the attitude of the technical press towards this subject must have been

struck by the unanimity of the approval expressed in papers devoted to different branches of lighting. That it has been found possible to give satisfaction in so many different quarters is, we think, very largely due to the manner in which those representing both electric and gas lighting have acted together in harmony on this occasion. The Commission, as the sequel proves, acted wisely indeed in inviting the assistance of representatives of the Gas Referees and the Gas Institute.

A rather curious juxtaposition of objections to the status of the Zürich International Photometrical Commission occurs in the section of the report of the International Electrotechnical Commission dealing with units of light. Prof. S. P. Thompson, it will be noted, pointed out that, singular to relate, the Gas Referees, the only legal British photometrical experts, were not represented on that Commission. Objection was also raised by the German representative, Dr. Budde, to the fact that the electrical profession in that country was not adequately represented.

Happily, as we stated above, the announcement on this occasion has given general satisfaction and should, we think, carry weight because of its truly international backing as well as its intrinsic value. Finally it may be pointed out once more that the success of the concerted action on the part of those representing gas and electric lighting on this occasion is a happy augury for the future, and we venture to hope that it may be made the precedent for mutual assistance in other much-needed directions.

Municipal Interest in Illumination.

We have often pointed out the obvious duty of municipal authorities of taking a keen interest in the lighting of the streets, public places, and public buildings in the district for which they are responsible. It has frequently been demonstrated how efficient is good lighting in promoting order and security in the streets, and there are those living to-day who can bear witness to the riotous conditions which prevailed before efficient illumination was introduced.

But this is only one aspect of a broad subject with which authorities are now called upon to deal. Illumination is closely connected with many social and public questions of to-day. The social reformer who is impressed with the duty of improving the housing conditions of the poor should remember how influential are miserable and inadequate conditions of illumination in causing people to acquiesce in the dirt and disorder around them. The planning of towns, the broadening of thoroughfares, and the raising of the standard of beauty in a city cannot proceed along perfect lines if the provision of adequate and tasteful conditions of illumination is not borne in mind. The people want air, but they need light as well.

At the municipal exhibition held in London last year we had an opportunity of drawing attention to this matter (see *The Illuminating Engineer*, June, 1908). At the present day, when the responsibilities assumed by municipal and civic authorities tend to grow ever more involved, it is desirable that the claims of good illumination should be considered simultaneously with other developments.

In the United States there has recently been a marked growth of interest in civic affairs, and we observe that, at the City Planning and Municipal Art Exhibition held in New York during the past month under the auspices of the Municipal Art Society, many social questions such as housing and transit conditions, the design of public parks and buildings, &c., were brought before the public notice.

It is therefore particularly gratifying to find that on this occasion the position of illumination as a subject of importance to the general public was duly recognized, and that a special exhibit of recent methods of street-lighting, &c., was organized under the

direction of the Illuminating Engineering Society. A lecture was also delivered by Mr. E. L. Elliott, Editor of *The Illuminating Engineer* of New York, entitled 'Art in Public Lighting.'

We hope to refer to the proceedings on this occasion in greater detail in a subsequent number. Meantime, we congratulate our friends in the United States on their enterprise, and we hope that both there and here the importance of the subject of illumination, from the public and national standpoint, will come to be more and more generally appreciated.

The Lighting of Poor-Law Institutions.

This subject formed one of many considered in the recently issued report of the Committee on Machinery and Engineering Staffs at Poor-Law Institutions, appointed by the President of the Local Government Board.

It will be generally agreed that the lighting of such institutions is a matter demanding careful supervision, if only from the standpoint of expense. The report very properly does not attempt to lay down any definite rule regarding the costs of different illuminants, remarking that this is very largely dependent upon local conditions. It is, however, suggested that much greater care might often be exercised in order to control the consumption of gas and electricity than at present, and, indeed, the published figures in the appendix, regarding the costs of electric and gas-lighting per head in different institutions, show very considerable variations.

We find no difficulty in believing that a considerable sum might often be saved to the ratepayers by securing competent advice before the lighting installation is designed, or even by such subsequent modifications as may be possible from time to time after the actual lighting scheme has been decided. On the other hand, it is obvious that such figures as the above cannot be taken as a definite evidence that the lighting is wasteful in some cases, simply because institutions of such varying character are included, and therefore both the objects and standard of the lighting adopted doubtless differ very greatly too.

In addition, the system of lighting adopted in infirmaries, &c., provided for people in an invalid and very susceptible condition, ought certainly to comply with certain definite and simple recommendations from the hygienic standpoint. At the present moment it would clearly be unwise to attempt to state these conditions in detail. There is, however, one salutary rule, to which reference is made above, namely the exclusion from the field of view of any source of light above a certain intrinsic brilliancy, which we should like to see definitely recognized and enforced.

We trust, however, that in years to come it will be found possible, with the assistance of the Illuminating Engineering Society, to frame definite recommendations on this point.

The Progress of the Illuminating Engineering Society.

On Tuesday, May 25th, a friendly meeting of those interested in the formation of the Illuminating Engineering Society in this country was held at St. Bride's Foundation Institute, Bride Lane, E.C. In the absence of Dr. H. Parsons, the Chairman of the Executive Committee, the chair was taken by Mr. Chas. Hastings, whose experienced services were much appreciated. The meeting was well attended and the keen interest and enthusiasm of those present may be taken as a hopeful sign for the future of the Society. It was also fitting that this meeting should have been held in the same building as that in which, in the autumn of 1907, the now Hon. Secretary read a paper before the Association of Engineers in Charge entitled 'The Province of the Illuminating Engineer,' emphasizing the need for an Illuminating Engineering Society.

At this meeting the Draft Statutes and By-Laws, giving the general outlines of the scope of the Society, were

duly ratified and are published in this number. Our readers will therefore have full opportunity of judging for themselves the international and impartial spirit which it is desired to maintain, and we hope that this will serve to convince any who, it may be, have not yet realized the exact nature of our intentions. It is now proposed to spend the summer months in preparing the ground for the next season, and it is hoped that our first session will be a thoroughly successful one. Meantime we renew our invitation to those interested to come forward and join the Society, and would like to draw attention to the form of application enclosed with this number.

On the present occasion we do not desire to dwell in detail upon the good work that has been done up till now, meaning to return to the matter in a subsequent number. There is, however, one point, which has often been raised, on which a few words may be said. We still occasionally hear dubious remarks regarding the possibility of getting those connected with different illuminants and different professions to work harmoniously together. Co-operation of this nature is, of course, the very key-note of the aims of our Society.

Let it be said once more that so far as the organization of the Society has progressed, we have not encountered any signs of this trouble. We have received applications from many representatives of different trades and professions, from all quarters of the globe, who all unite in considering that the Society has a useful place to fill and a great future before it. Our correspondence regarding the formation of the Society has been remarkably free from unpleasantness of any kind, and, to the best of our knowledge, our journal has invariably met with sympathetic and cordial treatment. From those whose assistance and advice we hoped to benefit we have received nothing but kindness. The meetings of the very representative Executive Committee of the Society have also been conducted throughout in a perfectly friendly spirit, and we see every reason to believe that the same conditions will prevail in all future dealings of the Society.

A List of Works on Illumination.

We have before us a list of the works and papers on subjects connected with illumination, available in the Public Library of New York. The recognition of illumination as a separate subject *per se* is of such comparatively recent date that there are probably not many such lists in existence, but the one to which we refer is both an exceedingly useful compilation in itself and an expression of the need for such specialization experienced in the United States.

The list contains well over a thousand distinct entries, and this corresponds with a very much greater number of actual references to works published in Europe and the United States. The constant stream of publications bearing more or less directly on illumination, as may be seen by a glance at the contents of our 'Review of the Technical Press' each month, makes it essential for constant additions to be made in order that such a list may be kept reasonably well up to date. In the case of a new subject like illumination, where developments succeed each other with such extreme rapidity, this is specially desirable, and we hope that our monthly international record is found of value by our readers.

It is to be hoped that scientific and other libraries in this country will likewise make a practice of regarding illumination as a special subject and keeping much-needed records of the literature relating thereto.

This is a piece of work which might profitably be undertaken by the Illuminating Engineering Society in this country very shortly. Meantime we should welcome co-operation from members towards this object in the form of particulars of books and treatises which have come under their notice as being of interest in this connexion.

LEON GASTER.

Review of Contents of this Issue.

Mr. A. P. Trotter (p. 367) concludes the section of his article dealing with PHOTOMETRIC SCALES, giving a résumé of the MOVING MIRROR METHOD on a photometer-bench, which obviates the necessity of moving either photometer or sources of light.

He next proceeds to describe the PERFORATED SCREEN TYPE OF PHOTOMETER and gives some directions as to the method of its preparation.

Dr. M. Gaster (p. 371) contributes an article on the subject of THE WORSHIP OF LIGHT. He points out how the religious conceptions of the nations of former times were largely influenced by their perception of the variations of natural daylight and the motions of the heavenly bodies. The night was to them a time of fear, for no effectual means of artificial illumination were at their disposal; thus it came about that the light-yielding sun and moon were deified. On the other hand, the effect of over-exposure to the sun's rays was realized, and it is probable that many ideas of past ages will be corroborated by the scientific experiences of to-day bearing upon this point. This article is followed by a short résumé of British Legislation on Factory Lighting (p. 373).

An important feature in the present number is the publication of the DRAFT CONSTITUTION AND BY-LAWS OF THE ILLUMINATING ENGINEERING SOCIETY, as ratified at a recent meeting (p. 377). A brief résumé of the proceedings at this meeting are given on p. 375. In addition to the resolution expressing approval of the Constitution and By-Laws several other decisions of importance were taken. It was decided that the Executive Committee, appointed on Feb. 9th of this year, should be reappointed, with the power of adding to their number, in order to proceed with the affairs of the Society during the month of June and the summer vacation, and to approach and invite certain gentlemen to act as officers or on the Council of the Society. It was also decided that the Executive Committee should be free to receive as members gentlemen interested in the objects of the Society duly proposed and seconded previous to the opening commencement of the first session of the Society in November. At the conclusion of the meeting it was agreed that the gentlemen present and all those who had previously intimated a desire to become members should be duly enrolled as such.

Mr. K. Sartori (p. 384) deals with MODERN INCANDESCENT ELECTRIC LAMPS. He describes some experiments which include life-tests on various types of lamps, and discusses the value of the so-called "short-life" overrunning method of testing, which in his experience, was found to be unsatisfactory. If any specified overrunning test is to be undertaken he prefers that it should be carried out with an excess of 10 per cent over the normal pressure rather than 20 per cent, as is generally recommended. He also criticizes the conventional method of specifying the "useful life" of a lamp, and considers it constitutes an inaccurate basis of comparison.

This article will be continued in our next.

In the present number the article by **Dr. E. P. Hyde**, and others, on the SELECTIVE RADIATION OF GLOWLAMPS is concluded (p. 389). The authors summarize the conclusions to be drawn from the experiments described, the main result being that all the common types of metallic filament lamps exhibit a greater or less degree of selective radiation.

Dr. C. R. Bohm (p. 395) continues the series of notes on INCANDESCENT GASLIGHTING. The present section again contains a description of different modern processes and patents bearing

upon the technicalities and manufacture of artificial silk mantles.

Dr. C. Charitschkoff (p. 401) contributes another note on the TESTING OF VARIETIES OF PETROLEUM INTENDED FOR USE WITH INCANDESCENT BURNERS. He points out that the conventional tests of petroleum with regard to colour, flashpoint, &c., do not suffice in this connexion and describes a form of apparatus used by him for examining the qualities of oil for the above purpose.

Two notes of considerable interest occur on pp. 392 to 393, both dealing with THE PROPOSED INTERNATIONAL UNIT OF LIGHT, and issued by the International Electrotechnical Commission and the National Physical Laboratory respectively. It is now announced that a proposal is awaiting definite international recognition to the effect that Britain, France and the United States should in future adopt a common unit of light of the same value as the pentane candle ; in countries using the Hefner standard, on the other hand, a value will be employed which is exactly 0·9 of this unit. This, of course, constitutes a much needed simplification, and it may be hoped that in the future it will be found possible to establish a single international unit which will meet with general acceptance.

Mr. A. J. Marshall (p. 406) contends that it is physiologically preferable to utilize white LIGHT SYMBOLS ON A DARK GROUND rather than the conventional and reverse arrangement. The most perfect conditions, he suggests, would be met by symbols of a yellow tint on dark green. He also points out that the matter is of some commercial importance, in that the habitual use of dark-coloured paper and a light ink might mitigate the danger of the supply of trees becoming exhausted owing to the ever-increasing demand for wood-pulp.

A paper by **Mr. W. H. Fulweiler** (p. 409) deals in a very complete manner with the STRUCTURE OF FLAMES AND INCANDESCENT MANTLE LUMINOSITY. The present section of the paper is mainly devoted to the scientific phenomena underlying the theory of radiation and light-production and is accompanied by a very useful collection of references to this subject.

Among other articles of varied interest mention may be made of the notes dealing with the EFFECT OF SURROUNDINGS ON THE AVAILABLE GROUND ILLUMINATION (p. 404), and the subject of PORCHLIGHTING (p. 405). These two contributions deal with closely related subjects. On p. 414 will be found a contribution dealing with various types of DEVICES FOR LUMINOUS SIGNS. These methods of securing automatic periodic action through the intermediary of heat and without motor and commutating arrangements are of considerable interest. Reference may also be made to the note on the LIGHTING OF FLEET STREET BY INVERTED HIGH PRESSURE GAS LAMPS (p. 402).

In the CORRESPONDENCE COLUMNS a letter appears dealing with the existing methods of specifying the EFFICIENCES OF GASLAMPS, and referring to the recent article by Prof. H. Strache (*Illuminating Engineer*, May, 1909). It is pointed out that the figures quoted in Germany and in this country seem to differ considerably, and that it is very desirable to establish some common basis of action. The letter from **Mr. Marconi** dealing with the effect of wireless waves on the human organism, as recently discussed by Dr. Bellile (See *Illuminating Engineer*, April, 1909, p. 278) is also reproduced. It is suggested therein that no evil effects need be feared provided satisfactory means are taken to screen the eyes from the spark.

The TRADE NOTES in the present number (p. 417) include a variety of subjects, including TRAINLIGHTING BY ELECTRICITY, THE GENERATION OF ELECTRICITY FROM WINDPOWER, GASLIGHTING FIXTURES, &c., &c.

On pp. 427 and 431 will be found the usual comprehensive **Review of the Technical Press** and the **Patent List.**

TECHNICAL SECTION.

[*The Editor, while not soliciting contributions, is willing to consider the publication of original articles submitted to him, or letters intended for inclusion in the correspondence columns of 'The Illuminating Engineer.'*

The Editor does not necessarily identify himself with the opinions expressed by his contributors.]

Illumination, Its Distribution and Measurement.

By A. P. Trotter,

Electrical Adviser to the Board of Trade.

(*Continued from p.* 298.)

The Moving Mirror System.—As there are marked advantages in avoiding movement of the lamp to be tested, and of the working lamp and the photometer head, it is worth while to consider an arrangement in which all these are fixed, and the principle of the squares of the distance and a carriage running on a bar is retained. The lamp to be measured is placed at L, the photometer head at P (Fig. 73), and the working lamp is placed at W immediately behind the photometer head, as close to it as is convenient, and, of course, well screened from the observer. All these are fixed during work. A pair of mirrors, of good plate glass, set at 45° reflect the light from the working lamp into the photometer head. The mirrors are mounted on a carriage which runs on the bar. The broken line represents the axis of the bar or a line parallel to it, and the dotted line represents the path of the light.

The mirrors must be so adjusted that if the photometer head and the lamp to be tested are removed, the image of working lamp W appears in the photometric axis, as though it were mounted on the bar. If the mirrors are moved one inch, it is as though the working lamp had been moved two inches. This arrangement practically doubles the effective length of the right hand part of the bar, and should prove an advantage in factories where photometer benches take up so much room.

The absorption of light by the mirrors, and indeed their gradual alteration by tarnishing is of no importance if the method of double weighing is used. The mirrors may be cleaned whenever the working lamp is cleaned and checked. For ordinary electric glow lamps the mirrors may be 4 in. (100 mm.) square. The scale is a scale of reciprocals of squares. The virtual distance of the working lamp W from the photometer head is

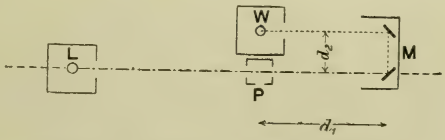


Fig. 73.—The Moving Mirror Method.

twice the distance d_1 Fig. 73, plus the distance d_2 (that is the distance between the axis of the working lamp and the photometric axis of the head).

If two workers are employed, one to watch the photometer and other instruments, such as voltmeter and ammeter, and the other to change the lamps and to mark them, the pointer may be attached to the mirror carriage and the scale fixed to the bar with the high numbers to the left and the low ones to the right. The worker at the

photometer makes the adjustment of the mirrors by means of a rod, and calls out the readings of the instruments, the other worker who changes and marks the lamps reads the candle-power on the scale. If, however, the photometer worker is to read the candle-power, the scale must be arranged with the high numbers to the right and the low ones to the left, and should be mounted on a light bar carried by the carriage. The index is stationary and may be fixed below the photometer head. In either case the scale must be so set that if the mirrors could be brought up to meet the working lamp W and the photometer head, reducing the distance d_1 (Fig. 73) to nothing, the zero would be at a distance beyond the index equal to the distance d_2.

Where two workers are employed, the lamp to be measured may be placed behind the photometer head (at W, Fig. 73) and the working lamp at L. A simple scale of squares must be used in that case, and the illumination of the photometer field is constant.

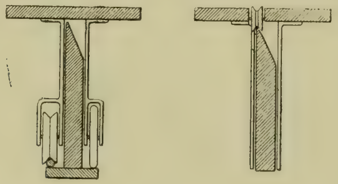


Fig. 74.—Section of Photometer-Bar and Carriages.

This arrangement of mirrors was suggested for use in an illumination photometer by Martens.*

The Construction of Bar and Scales.—The scales of old-fashioned gas photometers were perhaps as inconvenient for reading as it was possible to arrange. The graduations were fine and the characters stamped in faint black, or worse still, red on a polished brown wooden bar; or what was hardly any better, a boxwood strip expensively inlaid in mahogany. These photometers were an assemblage of apparatus of different kinds, including meters, pressure gauges, thermometers, governors, candle-balance, and other accessories, a remarkable feature being a great elaboration of cabinet work and velvet curtains. To-day the word photometer has a much more restricted meaning. The German fashion is to engrave the scale on a metal tube or on a strip of metal fastened to a tube. A pair of tubes constitute the bar. The tubes are lacquered with a black varnish, but this soon wears off, and a troublesome reflection of light is the result. A wooden bar at least 3 in. (say, 75 mm.) deep, and ¾ in. (20 mm.) thick is as good as anything. The back arris must be bevelled and painted dull black to avoid reflected light. Light is liable to fall on and to be reflected at a large angle of incidence from a flat top of a bar. A pair of ledges may be provided for the wheels of the movable carriage. Two wheels may be grooved and run on a rod, and the third may run on a flat, Fig. 74. Or the carriage may run mono-rail fashion, on two wheels on the edge of the bar, the carriage being nearly balanced on them.

The best kind of scale is white glass with the graduations and figures etched and blackened: such a scale is used with the Gas Referees photometer. The next best is a scale painted in black on a ground of white paint, either direct on the bar, or on a strip of zinc. The easiest scale to make is on drawing paper carefully mounted on the bar to avoid distortion, and well varnished.

The German method of arranging a photometer seems to be modelled on the laboratory apparatus known as the optical bench. Various optical instruments and fittings are mounted on pillars, and these are erected on slides or carriages which are adjusted on the bench. The Lummer-Brodhun photometer head is generally mounted on such a pillar, and the lamp holders are similarly mounted, the lower ends of the pillars drop between the two rods which constitute the bar. There are good reasons for such construction in the case of an optical bench, but none in the case of a photometer for industrial work or for engineers' use.

* *The Illuminating Engineer*, Vol. 1, p. 502; *The Electrician*, Vol. 57, p. 173.

The photometric axis should not be unnecessarily raised above the bar. Tall pillars need wide bases or carriages, and this entails unnecessary mass, and prevents freedom of motion. In order to allow such large apparatus as a Harcourt pentane lamp to be used, the bar itself need not be extended to the zero of the scale, but plumb lines can be fixed to represent the plane of zero. The bar may have a removable piece which can be unscrewed or folded back when such apparatus is used. For ordinary work the largest lamp likely to be used will settle the height of the photometric axis above the bar. A height of 5 in. (say, 125mm.) is enough to take a Hefner lamp, or a Fleming Ediswan standard.

The perforated Screen Photometer.—I was led to design this form of photometer in 1892 (not having heard of the Conroy photometer at that time) after a long series of experiments in illumination in photometry. Illumination photometers as a class will be described later, but an account of the development of this photometer may be of interest here. I wished to make measurements as near the ground as possible, and arranged a box 6 inches each way, having a Bunsen screen horizontally on the top, one side open, and a mirror inside set at 45°. A one candle-power electric lamp fed from an accumulator served to illuminate it. Hoods or tubes were used to exclude stray light, and the lamp was moved along a graduated scale. As it was impracticable to see both sides of the screen at once by means of mirrors, I proposed to observe the screen perpendicularly, and to graduate the scale by experiment. But I at once found that no balance could be obtained when the screen was viewed from a point immediately over it, without a very great disproportion between the illumination of the two sides of the screen. That is to say, when the illumination on the upper side was 1 foot-candle, the one candle lamp had to be much more than 1 foot from the back of the box. Viewing the screen at a definite angle was difficult. A ground glass screen laid on the mirror was tried. This was found unsatisfactory, but the instrument began to assume a practical form when the mirror was replaced by a white card. Numerous experiments were made with different kinds of Bunsen spots and screens. Tracing paper stretched over a white card in which a star-shaped hole had been cut was found to be better than any grease spot. The two sheets of paper used in the Leeson disc were unnecessary since only one side of the screen was used. A scale was graduated by experiment, and this arrangement was practically used for street work. Further experiments with the view of finding the most sensitive Bunsen spot suggested the use of ground glass instead of tracing paper, and an oiled spot suggested the use of clear glass

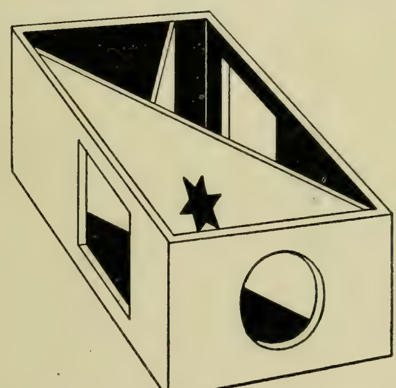


FIG. 75.—The Perforated Screen Photometer.

or of a simple cardboard screen with a star-shaped hole in it.* This was found to be far more sensitive than any of the previous arrangements.

Leaving the further development of this primitive illumination photometer until a later section, the practical form of this arrangement as a candlle power photometer may now be described.

Two screens (Figs. 75 and 76) are set at an angle of 70° with each other, the angle of incidence of the light is 35° as with the Thompson-Starling photometer. I have found no better material than good white Bristol board (white card-

* Trotter on A New Photometer, Proc. Phys. Soc., London XII., p. 355, and *Phil. Mag.*, July, 1893.

board) for these screens. The glaze must be removed with a damp cloth. When dry, the board should be laid face downwards on a piece of glass, hard wood, or celluloid, and a hole cut with bevelled edges. A star-shaped hole is a good shape. The edges which face the observer when the photometer is used must be sharply bevelled, those turned away from him may be square. A sharp knife must be used. It is better to cut a small hole first and enlarge it by paring. This avoids burnishing the matt surface by pressure. If it is neatly cut, and the cardboard of good quality, absolute disappearance of the hole is possible when a balance is effected, but to

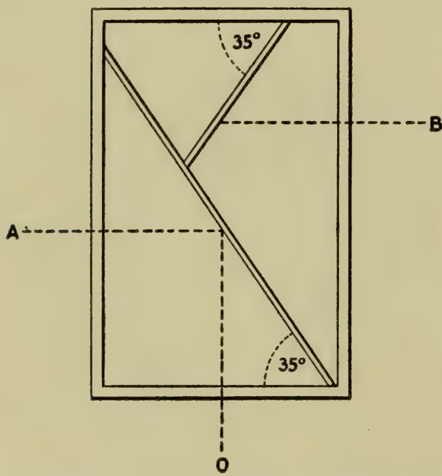


FIG. 76.—The Perforated Screen Photometer-Plan.

secure this illusion the hole should not be more than three-eighths of an inch (say 10 mm.) over all. A square hole or slot is much more easy to make. A round hole can be cut by fastening the card against a face plate in a lathe. Fig. 77 shows the back view of a star hole cut in a blackened card ; when seen foreshortened the star is symmetrical.

It is necessary that the hole should be neatly cut, and that the cards should be fairly flat. The back of the perforated one must be blackened and screened from the light falling on the back screen.

This photometer is, as has been shown, the outcome of a series of modifications of an ordinary Bunsen grease-spot. It is at the same time a very slight modification of the Conroy photometer which seems to have nothing in common with a Bunsen spot. It carries out in the most simple possible manner the principle arrived at with so great complication and expense in the Lummer - Brodhun photometer, namely seeing one screen through a hole in another.

I am not responsible for certain varieties of this pattern which have been called the "Trotter Photometer." There is so little new in the principle that I have never given it that name.

I prefer to stand at least at arm's length from the photometer head, and sometimes farther, working the lamps with cords or a light rod. It is then easy to use both eyes. If it

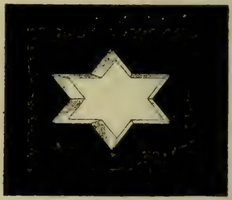


FIG. 77.—Star-hole, as seen from the back.

is desired to cut down the area of the front screen, this should be done by a black oval mask on the screen and not by the use of a diaphragm in the front of the photometer head. The use of a diaphragm of small diameter interferes with the free use of both eyes. When the spot is observed from a short distance the illusion of disappearance is lessened, and one eye must be used. I have used a modification of this photometer for examining the reflecting power of various substances, and at various angles.* It was generally necessary to use one eye if the nature of the surfaces of the two screens were not alike. Instead of shutting one eye a sheet of blackened card, having a hole about a quarter of an inch in diameter, may be used as a mask.

* *The Ill. Eng.*, Vol. II., p. 80.

(*To be continued.*)

The Worship of Light.

By Dr. M. Gaster.

Many attempts have been made to define what is meant by civilization, and to measure its progress. It would serve no purpose were I to repeat here what has already been said on that head. Suffice it to state that each one who has ventured to answer the query or to define "civilization" has done so from a more or less partial point of view. To one the principle of liberty appeals, to another that of equal justice, to a third the spread of education; again to others a greater degree of mutual forbearance and tolerance has been deemed an adequate reply. To a certain extent all these views have been justified; for civilization partakes of all of them.

But another principle may also be put forward as a correct and satisfactory definition of "civilization" and as a fitting standard by which to measure its progress. Real civilization means "dissipation of darkness" be it moral, be it physical. The substitution of light for darkness, the change of night into day mark its onward march. And the standard by which to measure its progress is the greater area covered by light and the successful endeavours of man to cope with darkness.

A glance back at the history of mankind must convince us of the justice of this claim set up on behalf of light. The very fact that so many interests are now concentrated upon the spread of light and upon its distribution to the best advantage of all concerned must be taken as a high watermark of progress. The further we retrace our steps the more we can see how little was done in former times to banish "the terrors of the night" now taken as a mere form of speech, but then invested with very serious and real significance; how little they cared, or were able to do, in former times to protect the life and limb of the travellers by night and of the indwellers of towns who ventured out in the dark. The illuminants were primitive, and the flickering light of an oil lamp—then already a great advance upon the wood torch—was easily extinguished by the slightest gust of wind.

It is difficult for us, brought up almost in a blaze of light, to realize the primitive state of society when artificial light could not be easily obtained, and only after it had been secured was it realized to be a source of protection and of comparative safety. The higher we ascend the stream of tradition and the flow of civilization, the more we learn of the fear which seized man at the setting of the sun, when darkness covered the face of the earth and all the powers of evil were let loose. There was practically no protection against the attack of invisible foes and man hailed with delight the first rays of the reappearing light. No wonder, therefore, that light was the first and oldest object of worship.

There is no religion of olden times—and in fact none in modern times—in which the light is not the centre of worship, with this difference, that in modern times it has assumed a more spiritual aspect and is taken as a moral symbol and not as a physical fact; whilst in olden times the light was the very object before which the worshipper prostrated himself in awe and reverence. It is the keynote of ancient religious life, and of many of the queer customs which have survived in popular prejudices and practices.

It must be remembered that to the primitive mind everything is alive and personified. The heavens, the sun, the moon, the stars, the clouds, even in spite of their shifting nature are all more or less true human beings of great power; they are living personalities and are looked upon as the creators and masters of everything. It matters little that, in later times, instead of believing the sun or the moon to be the god itself, a spirit was made to live in

them as their master, and the heavenly bodies became the abodes of genii. The worship was rendered from the beginning to these heavenly centres of light. However rapid a survey we make, starting from ancient Egypt down to the latest phases of Roman mythology, everywhere we find the Sun being worshipped as a god, because of the light which it sheds, and the life which is produces wherever its rays penetrate. Ra—the "Sun"—is one of the chief gods of Egypt, and the king becomes afterwards the "son of Ra," the sun-god. All the numerous gods and goddesses represented on Egyptian monuments are mere local modifications of this general idea: the worship of the personified god of light.

Every phase and every change in the course of the sun in the sky is then watched and noted, and endowed with symbolical meanings. In the famous legend of the god Osiris, worshipped throughout a period of close upon 4,000 years, the story of the fight between light and darkness, day and night, good and evil, summer and winter, life and death, is typified as a human tragedy. The statue of Memnon sang when the first rays of the sun struck the stone. The sun, sailing in a boat over the heavens, travels when the night falls, under the earth, to rise again in the morning at the appointed spot. This reappearance of the light became then the symbol of reappearing life and the emblem of the Solar disc on the horizon symbolizes life which renews itself. And similarly the life of man has been identified with the apparent life and death of the sun—its appearance and disappearance—during the day, and the rising and sinking during the year. They had special festivals at the renewal of that life in the early spring, and mourning ceremonies at the apparent death in autumn, when, according to the legend, the evil power conquered the good, swallowed the light and kept it, but only for a while, for in the long run, the light would dissipate the darkness and come to life again, and bring life with it. The vegetation had also died at that period and everything came to a standstill, and now new life was budding again.

It would lead us too far to enter here at greater length upon some of these highly interesting details, which though of remote antiquity, have none the less been retained in another form in modern practices and in the celebrations on certain days of the year, such as the St. John's fire and the equinoctial celebrations, the origin of which the people have entirely forgotten. They treat them as mere old world customs and superstitions. Still, the idea of the sun-god who lives and fights and dies and comes to life again is not limited to Egypt. We meet it all over Asia and even ancient America and I shall come back to it in the course of this rapid survey of the worship of light. For men did not worship any abstract idea; they looked upon the divine as a human being, whose life they believed to be immeasurably longer and whose power infinitely greater than their own, to whom they owed all that which they prized most—life and health and wealth and prosperity; and success in war.

If we pass on to the next old religion of Asia (without entering into the question as to which of the two might be the older), the ancient Assyrians and Babylonians also worshipped the sun as the centre of light, and their gods were mere personifications of the Sun. The name of one of the greatest in their Pantheon is typical; he is called "Shamash," *i.e.*, the sun. But here we find already an addition made, inasmuch as the sun is no longer the only centre of light as he was in the cloudless sky of the Egyptians. Climatic influences caused the moon to be treated as one of equal, or at any rate, of great importance. In the height of summer the light of the sun is beating down fiercely on the inhabitants of the plains of Western Asia, and the sun is no longer only a god of good, but its rays can be the cause of great hardship and suffering. The darts of the sun are therefore to be dreaded as much in the summer as are the poisoned arrows of the evil spirits of illness and of darkness. The spirit "that walketh by midday" is not a mere figure of speech. But all the same the whole worship turns round the light coming from the

heavens, which alone dispel the darkness successfully, and drive away demons and all causes of illness. To it the priest turns with his incantations, and from the god residing in the sun, the creator of the world and of man, he expects delivery from troubles, and assistance in his undertakings. To him he brings sacrifices and hopes for rewards. That the moon, as already remarked, is also playing a great part in this system of worship is perfectly natural and easily to be understood, when one remembers the brilliant light of the moon in that part of the world and the fact that most of the travelling is done by the aid of its silvery light, which, more even than that of the sun, dispels the terrors of the night and drives the demons back to their haunts, and the wild beasts to their lairs. The stars as luminaries of heaven, with their glittering light, and notably the planets, share in the worship of the ancient Assyrians and Babylonians. From that part of the world emanates the whole of the belief in the influence which these luminaries have upon the destiny of man. Astrology has its home and birthplace in Babylon, and has spread thence all over Asia and Europe, and has held sway over the peoples of the West for upwards of two thousand years. And who can say that the belief in the influence of the stars and of the light which they emanate is dead? I may have to recur to this subject in a subsequent contribution, and it may be that we shall find the most recent results of the illuminating engineer and the discovery of the remarkable effects disclosed by the latest investigations of the ultraviolet rays upon the human body corroborating, though in a different manner, the ancient beliefs in the influence which the light of certain stars and of certain colours have upon the human body and upon human well-being in general. It may turn out that these were not mere idle speculations resting on imagination, but real experiences, facts empirically ascertained, which they in olden times were unable to establish upon a scientific basis, or to trace definitely to their ultimate source. Of the effect which light had upon the whole range of human life and upon nature the people were fully aware; they saw in it the grandest embodiment of divine power and they rendered it divine hommage.

In a subsequent contribution we shall follow this worship further East, and then retrace our steps and sketch as briefly as possible its influence in Europe among the Greeks and Romans and in the old North mythology of the Teutonic races.

(*To be continued*).

British Legislation on the Lighting of Factories and Workshops.

In our last number we published a translation of the report of the Conseil d'Hygiene de la Seine on factory lighting. Through the courtesy of Dr. T. M. Legge, the Medical Inspector of Factories to the Home Office, we have received some information relating to recent modifications in the legislation of this country on this point, which are substantially as follows.

The report of the Medical Inspector, incorporated in the annual report of the chief inspector of factories for 1902, the regulations enforced for such trades as the Vitreous Enamelling of Metal or Glass, contained no section specially devoted to lighting; this matter had been the subject of consideration, however, as the following paragraph from a paper by Dr. Legge on Industrial Lead Poisoning in 1901 (see the *Journal of Hygiene*, vol. i. No. 1, p. 106, 1901) shows:—

"The uses of lead and lead compounds have been so long known, and the methods of manufacture have undergone so little change, that they continue to be carried on often in the

same building, which served a like purpose a century ago, when the value placed on human health was not what it is to-day. Persons exposed to lead with its anæmia-producing affect want sunlight and air, which structural conditions often allow to enter but sparingly."

It is to be observed, however, that the Statutory Rules and Orders for 1908, for workshops and factories, in which dangerous and unhealthy industries are carried on, contain the following definite recommendations relating to ventilation and lighting.

1. Every room in which any enamelling process is carried on :—

(*a*) shall contain at least 500 cubic feet of air space for each person employed therein, and in computing this air space no height above 14 ft. shall be taken into account.

(*b*) shall be efficiently lighted, and shall for this purpose have efficient means of lighting both natural and artificial.

The Incorporated Society of Medical Officers of Health have also issued printed suggested requirements for underground bakehouses for the guidance of medical officers of Health in advising their sanitary authorities as to requirements that may be needed, under section 101 of the Factory and Workshop Act, 1901, so as to secure uniformity of action throughout the country. Among these they say, as regards light :—

"The underground bakehouse shall be adequately lighted with daylight throughout, to the satisfaction of the sanitary authority, and the lighting maintained shall be such that an official copy of the Abstract of the Factory Act may ordinarily be read in all parts of such bakehouses between the hours of 11 A.M. and 3 P.M."

The annual report for 1902 of the above society also contains the following comments by H.M. Chief Medical Inspector of Factories :—

"The requirements of section 101, 1901, that underground bakehouses shall not be used after January 1st, 1904, unless certified by the District Council as suitable for the purpose, has led to notable efforts being made by medical officers of Health through their incorporated society to define the requirements necessary in underground bakehouses before the granting of a certificate, with a view to securing uniformity of action throughout the country. Already in several towns action on the lines laid down in these suggestions has resulted in vastly improved conditions as regards lighting ventilation, cleanliness, and freedom, from damp in many underground bakehouses. Perhaps the most noticeable change is the improvement in the lighting of the premises which has been effected by the reflection of the rays of light through prisms on a level with the pavement impinging on a sloping surface of white glazed tiles.

"As many occupations are carried on under conditions comparable with those of underground bakehouses, the suggested requirements of the Incorporated Society may have a wider application in pointing out how alone healthy conditions of work can be secured in premises situated underground."

We are also informed that Dr. J. Robertson, now Medical Officer of Health for Birmingham, read a paper at the recent British Congress on Tuberculosis on 'Lighting, Ventilation and Aggregation in relation to the Prevention of Tuberculosis' (*Transactions* of the British Congress on Tuberculosis, vol. ii. p. 102). He emphasized in it the desirability of a standard for lighting in factories and workshops.

Access of Daylight to Westminster Hospital.

At the request of the Westminster Hospital, Mr. Justice Joyce recently granted an interim injunction restricting the height of the adjacent new Wesleyan Memorial Hall being built by the Trustees of the Wesleyan Twentieth Century Fund.

It was stated that if the proposed plan was executed the access of light to one portion of the Hospital would be interfered with, and the recovery of patients appreciably prejudiced and retarded thereby

The Illuminating Engineering Society.

(Founded in London, 1909.)

A meeting of those interested in the formation of the above society was held at St. Bride Foundation Institute, Bride Lane, Fleet Street, London, E.C., on May 25th, at 7 o'clock.

In the absence of Dr. H. Parsons, Chairman of the Executive Committee, the chair was taken by Mr. Chas. Hastings, who reminded those present that, at the inaugural dinner held on Feb. 9th of this year, an Executive Committee had been appointed in order to consider the drafting of the constitution of the society, &c. This Committee had held a number of meetings and prepared a draft of the constitution in due course, which had been circularized to a number of gentlemen who had expressed an interest in the Society. The Committee now desired to report progress, and to bring certain proposals before the meeting, in order that preparations might be made to enable the Society to enter under favourable conditions upon its first session next November. The chairman then called upon Mr. L. Gaster, the hon. secretary, to present his report.

Mr. L. Gaster briefly recapitulated the decisions taken at the inaugural dinner on Feb. 9th, and explained the nature of the work upon which the Committee had been engaged. He wished particularly to dwell upon the fact that, although the members of this Committee represented different interests and various aspects of illumination, they had worked together in perfect harmony, and the keen discussions which had taken place at its meetings had invariably been of an amicable nature. This, he thought, only illustrated what he had always maintained, that people with a common interest in illumination, though connected with different branches of the subject, could work together perfectly satisfactorily for the common good.

Mr. Gaster remarked that a large number of gentlemen who were not present had expressed regret at being unable to attend, owing to the inevitably short notice given. He had received many expressions of good will to the Society, and some, like Mr. Trotter, whom they were so pleased to see at this meeting, had altered their arrangements specially in order to be present; in no single case had he met with any expression of disapproval. The first point for the consideration of the meeting was the Constitution of the Society, which they all had an opportunity of studying previously and on which a great deal of careful effort had been expended by the Committee. He might mention, however, that there were still a few points on which the Committee desired to take legal advice and that it should therefore be understood that they should be free to make any trifling alterations that this course might render necessary.

The chairman then read a resolution, which was subsequently duly proposed by Mr. A. P. Trotter and seconded by Mr. Kenelm Edgcumbe, to the effect that this Constitution and By-laws met with the approval of those present, subject to such legal alterations or additions as might be found expedient.

Before taking a vote on this matter the chairman proceeded to pass from clause to clause in the Constitution and By-laws of the Society, inviting those present to make any suggestions that might occur to them on the matter.

Some discussion then ensued and an amendment was ultimately suggested to the effect that the vice-presidents, the hon. secretary and the hon. treasurer should hold office for one year only, eligible for re-election, instead of three years, as specified in Clause 8. It was pointed out, however, that the Illuminating Engineering Society differed essentially from many other societies in that it would initially contain representatives of many different trades and professions, viewing

matters from somewhat distinct standpoints, and that, therefore, it was desirable to give the original officers a sufficiently long term of office to secure the establishment of a continuous line of policy in the best interests of the Society, and also to become practised in their duties. Ultimately the amendment was lost, and the original framing of Clause 8 was adhered to. The above resolution was then duly moved and carried.

The chairman then passed on to the second point before the meeting. He suggested that it was desirable that the Executive Committee should be empowered to proceed with the business of the Society during the summer vacation, and intimated that the present Committee, comprising Dr. H. Parsons, Mr. J. Eck, Mr. H. T. Harrison, Mr. C. Hastings, Mr. J. Darch, Mr. J. W. Ife, Mr. J. S. Dow and Mr. Leon Gaster as hon. secretary, would be willing to continue their labours. The resolution that this Committee should be reappointed with power to add to their numbers, as might be found expedient, and should thereby form the nucleus of the first council of the Society, was then duly proposed and seconded and approved by the meeting.

The chairman also explained that it was desirable that some of the officers of the Society should be appointed previous to the opening session. The Executive Committee therefore requested to be empowered to approach a certain number of gentlemen to act in these capacities. The hon. secretary then proceeded to read out a number of names of gentlemen who, it was suggested by the Executive Committee, should be approached, and asked those present to suggest any additional names. As no other nominations were submitted, the names put forward by the Executive Committee were formally approved by the meeting, and a resolution was taken giving the Executive Committee the powers asked for.

It was also explained by the chairman that the Committee thought it expedient to gather as full a roll of members as possible previous to the opening of the next session, and in order not to lose time, it was proposed that they should have power to receive and accept as members of the Society any candidates applying for membership in the prescribed manner during this period; also that the gentlemen present and those who had previously intimated their desire to become members should be so regarded and placed upon the register of the Society. A resolution to this effect, authorizing the Executive Committee to act in this manner, was then duly taken.

The chairman then drew attention to the forms of application prepared by the Committee and a number of these were taken away by those present with a view to enrolling fresh members. The Illuminating Engineering Society was now an existing Society and a very cordial welcome was extended to those who sympathized with its objects and wished to take an active interest in its proceedings.

In conclusion a very cordial vote of thanks to the chairman was moved by Mr. A. P. Trotter, who complimented him upon the experienced and business-like manner in which the meeting had been conducted, and the meeting then terminated.

The Draft Constitution and By-Laws of the Society, as approved at this meeting, but subject to any minor additions or alterations as legal considerations may render necessary, are reproduced in the following pages, in order that the scope and objects of the Society may be appreciated by our readers.

Further particulars and forms of application for membership may be obtained from the Hon. Secretary, Mr. L. Gaster, 32, Victoria Street, London, S.W.

Draft Constitution of the Illuminating Engineering Society.

(FOUNDED IN LONDON, 1909.)

NATURE AND AIMS OF THE ILLUMINATING ENGINEERING SOCIETY.

1. The name of this Association shall be the Illuminating Engineering Society.

2. Its objects shall be the advancement of the theory and practice of illuminating engineering and the dissemination of knowledge relating thereto. Among the means to this end shall be meetings for the presentation and discussion of appropriate papers; the publication as may seem expedient of such papers, of discussions and communications; and through committees, the study of subjects relating to the science and art of illumination, and the publication of reports thereon.

Also the organization of, or participation in periodical national and international exhibitions of developments in illumination, and congresses dealing with the subject.

MEMBERSHIP.

3. The members of this Society shall be designated Members, Honorary Members, or Corresponding Members.

4. A Member may be any one interested in the objects of the Society, but at the date of election shall not be less than twenty-one years of age.

5. Honorary Members may be chosen from among those who are of acknowledged eminence in some branch of science related to illuminating engineering, or who, by reason of position, eminence, or experience, may be enabled to render assistance in promoting the objects of the Society. Honorary Members shall be entitled to all the privileges of Membership except the right to vote and to hold office therein.

6. Ordinary, Honorary, and Corresponding Members may be of either sex and of any nationality. The masculine pronouns, when used in these Statutes and By-laws, shall be read as applying to both sexes.

OFFICERS OF THE SOCIETY.

7. The Officers of the Society shall include a President, not more than twenty-five or less than ten Vice-Presidents, an Honorary Secretary, an Honorary Treasurer, and the Council, of which the President, the Hon. Secretary, and the Hon. Treasurer shall be, ex-officio, members.

8. The President shall hold office for one year only, but shall, after the lapse of a year, be eligible for re-election. The Vice-Presidents, the Hon. Secretary, and the Hon. Treasurer shall hold office for three years and shall be eligible for re-election at the conclusion of their period of office.

9. The Council shall contain representatives of different interests, trades, and professions concerned with illumination and allied subjects, who may be of different nationalities, and shall be so selected that those who have opposing interests commercially shall be equally represented on the Council as far as numbers are concerned, and, if possible, distributed in the following proportions:—

Three engineers prominently connected with gas lighting.

Three engineers prominently connected with electric lighting.

Three engineers connected with other systems of lighting (acetylene, petroleum, petrol-air, &c.)

Three manufacturers of illuminating apparatus, representing different systems of lighting, respectively, or interested in all.

Three Members representing the electrical supply companies, the gas companies, and the consumer, respectively.

Three Members connected with the architectural profession, surveyors, &c.

Three Members connected with physiological aspects of illumination and representative of the views of oculists and opthalmists.

Three Members interested in general physical science and photometry.

Three Members interested in the supervision of the illumination of public buildings, factories, schools, &c., representatives of fire insurance companies, &c.

The total number of Members of the Council shall not be less than eighteen or more than twenty-seven, and the different classes shall, as far as possible, be represented in equal proportions. In the event of additional Members being added the balance of the Council shall be, as far as possible, maintained.

10. One-third of the Members of the Council, representative of different

trades or professions connected with illumination, shall retire each year; the retiring Members shall be determined by ballot, in order of seniority of office, but the original Council shall hold office for three years. The positions of retiring Members must be filled by Members representing, as far as possible, the same classes as those of the retiring Members.

11. A vacancy in the office of President shall, in the absence of any nomination by the Council, be temporarily filled by the senior Vice-President. Vacancies in the office of Vice-President shall be temporarily filled by nomination by the Council.

ADMISSION OF MEMBERS.

12. An application for admission to the Society shall be made in a form prescribed by the Council, and shall refer to at least two Members of the Society; or if an applicant should be not personally known to two Members, references may be accepted to Members of professional societies of good standing, or to other persons whose good standing may be readily verified by the Council. If, in the opinion of the Council, further support for a Member's candidature be considered necessary, the recommendations of four existing Members shall be deemed sufficient; but the final consideration of a nomination for Membership rests with the Council.

13. Candidates for admission as Members must present a suitable form of application signed by two or more nominators, as directed above, as follows:—

"We hereby recommend [here state name in full, date and place of birth, rank, profession or business, usual place of residence, and qualifications for Membership of the candidate] as a fit and proper person to become a Member of the Illuminating Engineering Society [here must follow the names of two or more nominators, one of whom must have personal knowledge of the candidate]."

14. Applications will be considered at the next Council meeting after they have been received. The names of those whose nominations have been accepted by Council will then be read out at the next meeting of the Society, and will be ballotted for at the Meeting following. A majority of two-thirds of those present shall entitle a candidate to election.

15. Due notice of their election shall be sent to the newly elected Members, together with the form of assent for signature.

16. No person shall be entitled to any of the privileges of Membership until the annual subscription, or such other sum as is specified elsewhere as a composition in lieu of annual subscriptions, shall have been paid, and until the member shall have signed the following form:—

"I, the undersigned, desire to become a Member of the Illuminating Engineering Society, and hereby promise that, if elected, I will submit and conform in all respects to, and be governed by, the terms and provisions of the Constitution and the Bye-laws made in pursuance thereof; provided that whenever I shall signify in writing to the Hon. Secretary that I am desirous of ceasing to be a Member thereof, I shall be free from this obligation, after payment of any Annual Subscription or arrears which may be due from me at that period."

17. A Member may resign from the Society by a written communication to the Hon. Secretary, which resignation shall be accepted by the Council if the Member's subscription and other fees have been duly paid.

18. Honorary Members shall be nominated by the Council or proposed in writing by at least fifteen Members, and shall then be elected only by a four-fifths majority of the Council. The number of Honorary Members elected in each year shall not exceed three. Voting shall be by letter-ballot. A person elected an Honorary Member shall be duly notified by letter. If an acceptance is not received within six months after the dispatch of such notice, a second notice shall be sent, and if again no reply is received within an adequate period not exceeding six months, the election shall be considered void.

19. Foreigners and others not residing in Great Britain or Ireland, on election by a two-thirds majority of the assembled Council of the Society, may become Corresponding Members, without payment of subscription, and may attend, but not vote, at General or Ordinary Meetings, and they shall be entitled to receive *The Illuminating Engineer*.

EXPULSION OF MEMBERS.

20. Upon the receipt of a written request of not less than ten members that, for cause definitely stated in detail, a Member of the Society should be expelled, the Council shall consider the matter, and, if there appears to be sufficient cause, shall advise the Member concerned of the charges against him. The Member may then present a written defence and appear in person before a meeting of the Council, who, within two months shall finally consider the case, and if the defence be deemed not satisfactory, the accused Member shall be requested to resign and, in the event of his refusing to do so,

shall be expelled upon a two-thirds vote of the total Membership of the Council.

SUBSCRIPTIONS.

21. The annual subscription to the Illuminating Engineering Society shall be one guinea, which shall include the subscription to *The Illuminating Engineer*, the appointed official organ of the Society. After the first year the Council shall have power to alter this annual subscription, if found necessary in the interests of the Society; but the subscription shall not exceed two guineas within the first five years of the existence of the Society.

22. Honorary Members shall be exempt from all subscriptions.

23. Any Member may commute or compound for all future payments and become a Member for life, by payment of a sum not less than ten guineas.

24. The Council shall have power in each year to admit, by a three-quarter majority of the entire Membership of Council, three persons who are eminent in the science and art of illumination, or who have rendered special services to the Society, but are not, at the time being, members of the Council, to be Life Members of the Society without the ordinary formalities of election, and without any subscription whatever, but having all the privileges of membership.

25. A Member elected after six months of the fiscal year have expired shall pay one-half of the amount of the subscription for that year, provided that if he requests and receives a set of *The Illuminating Engineer* covering the entire year, the full annual subscription shall be paid. Any Member who is elected between the months of January and June shall be liable for the full annual subscription.

26. If the annual subscription of any Member residing in the United Kingdom shall be in arrear for one year, the Hon. Secretary shall give notice thereof to the Member; and if the said subscription shall continue in arrear at the expiration of six months after such notice, the Council having, through the Hon. Secretary, given the defaulting Member due notice of their intention, shall have power to strike the name of such Member off the register, and he shall thereupon cease to be a Member of the Society, but shall remain liable for any arrears of subscription which shall be due at the date of cessation of Membership; and it shall be the duty of the Hon. Treasurer to recover from persons who shall have ceased to be Members any arrears which may remain unpaid.

27. A defaulting Member may be reinstated by the Council and retain his original date of election upon payment of all back fees, being then entitled to a complete file of the publications of the Society to date, if in stock.

MEETINGS OF THE SOCIETY.

28. At Ordinary Meetings papers or demonstrations relating to some aspect of illumination or allied subject shall be read or performed, and will be followed by discussion on the part of the members present. Ordinary Meetings may also be set aside for debate on a prescribed subject approved by the Council, or for the discussion of papers read at other societies and in other countries falling within the scope of the interests of the Society, as the Council may direct.

29. A Member of the Society is at liberty to introduce a visitor at an Ordinary Meeting, and visitors so introduced may participate in the discussion, subject to the approval of the Chairman.

30. The chair shall be taken by the President at meetings of the Society, or, in his absence, by a Vice-President or some Member of Council or other Member selected at the meeting.

31. The Council shall have power to invite a distinguished visitor to deliver a lecture before the Society, which shall not be open for discussion, or to read a paper which shall be duly discussed in the ordinary way.

32. No decision on the merits of a paper read or lecture delivered before the Society shall be taken at the Meetings.

33. No paper can be read at any Ordinary Meeting of the Society unless it shall have been approved by the Council, but this approval shall not be taken as expressing an opinion upon the statements made, experiments described, or results arrived at in the course of such a paper.

34. The Session shall commence in November, the first Ordinary Meeting being held on the third Tuesday of this month. Ordinary Meetings shall, when possible, take place at 8 p.m. on the third Tuesday in each month. The Session shall terminate on the third Tuesday in May.

35. Any Special General Meeting, for a specified object, may be called by the Council, or upon a requisition to this effect signed by not less than fifteen Members, which must be received by the Council at least six weeks previous to the date of such a Meeting.

Notice of the holding of such a General Meeting, and of the purpose for which it is convened, shall be given in the number of the official organ of the Society published previous to the holding of the meeting.

36. No business shall be transacted at a special General Meeting for any purpose other than that for which it shall have been convened.

37. No Member whose subscription is one year in arrear shall be entitled to be present, debate, or vote at any General Meeting.

38. Motions made at General Meetings of the Society shall be in writing, and signed by the mover and seconder.

39. A quorum of the Society shall consist in not less than ten Members.

40. A Meeting of the Council shall take place, each month, on the day on which the Ordinary Meeting of the month is held. Five Members shall constitute a quorum.

41. A Conversazione may be held during the year where any novelties in connection with illumination or objects or processes of special interest may be made the subject of exhibition, if, in the opinion of the Council, their interest merits this display. Should the Council deem it desirable to hold such a Conversazione and to arrange for exhibitions of the character referred to, a Special Committee shall be appointed to consider the matter and undertake the organization thereof. At this Conversazione each Member shall be entitled to invite a friend, and the Council shall also have the power to issue special invitations.

PROCEEDINGS AT THE ANNUAL GENERAL MEETING.

42. The Annual General Meeting shall be held on a day in the month of June, and none but Members, Officers of the Society, or persons specially invited by the Council, shall be permitted to be present.

43. At this Meeting the Council shall render to the Society a complete account of their proceedings, a statement of the financial position of the Society, and of the receipts, payments and expenditure during the present year. Previously to the Meeting the Council shall select two Hon. Auditors who will report upon and sign the balance sheet for the year, a copy of which will be circulated among the Members of the Society previous to the Meeting.

44. At the General Meeting the election of Officers to replace vacancies, owing to death or retirement, shall proceed as directed elsewhere.

45. Any alteration in the statutes or bye-laws of the Society can only be proposed at the Annual General Meeting, but notice must be given to the Council of any motion to this effect, or relating to any other special business which it is desired shall be discussed at the General Meeting, not later than the last day in March.

46. Notice of the General Meeting shall be published in *The Illuminating Engineer* at least one month previous to the holding thereof.

47. In the absence of the President at the Annual General Meeting the chair shall be taken by a Vice-President or some Member of Council selected by the Meeting.

ELECTION OF OFFICERS AT THE ANNUAL GENERAL MEETING.

48. Previous to the General Meeting the Council shall notify all Members of the Society of vacancies in the Council, due to the retirement of Members, and of any other vacancies that periodically recur. They shall also send to each Member, not later than 1st of May, a complete list of the existing Officers and Members of Council, of the retiring Members, and of nominations put forward to fill the vacancies.

49. An application, to which the signatures of not less than ten Members are attached, shall, however, entitle the said ten Members to nominate another candidate, in addition to those named by the Council, to fill the existing vacancies. Such applications must be received by the Council not later than April 15th.

50. Two Scrutineers, who will examine and report upon the result of the ballot, shall be appointed at the Meeting. The candidates receiving the majority of votes will be duly elected, and their elections shall be announced by the chairman.

MANAGEMENT.

51. The Council shall transact all the ordinary business of the Society, undertake its general management, and from time to time may issue such regulations as they think fit for the welfare thereof.

52. Proposals to amend this Constitution shall be made in writing to the Council and signed by at least fifteen Members, and shall reach the Hon. Secretary not later than the last day in March. The Council shall consider such proposals and direct the Hon. Secretary to arrange for a letter-ballot on their adoption. Replies to be considered shall be received not later than May 15th, and shall be referred unopened to the scrutineers appointed by the Annual Meeting, who shall count such votes and report thereon. An affirmative vote of two-thirds of the entire vote cast by qualified Members of the Society shall be necessary to secure the adoption of an amendment. An amendment shall take effect twenty days after its adoption.

53. If no quorum be present at a Meeting called to consider an alteration in the Constitution of the Society, the Council shall proceed to call a second meeting not later than two months after the first before a decision in the matter can be taken.

54. By-Laws in interpretation of the spirit and letter of this Constitution, and for its execution, may be adopted by a majority vote of two-thirds of the entire Council. Votes on By-Laws shall be by letter-ballot.

55. At the beginning of the Session the Council shall proceed to nominate a Chairman and Vice-Chairman, who, in the absence of the President, shall preside over Meetings of Council.

56. The Hon. Secretary shall be the executive officer of the Society, under the direction of the Council. He shall prepare the business for the Council and record the proceedings thereof. He shall collect all moneys due to the Society, and deposit the same subject to the order of the Treasurer. He shall personally certify the accuracy of bills or vouchers upon which money is to be paid, and shall draw and countersign all cheques, which shall be signed by the Treasurer. He shall have charge of the books and accounts of the Society, and shall furnish monthly to the Council a statement of receipts and expenditures and monthly balances. He shall prepare annually a report for the Council and from time to time shall furnish such statements as may be required. He shall conduct the correspondence of the Society, and keep full records of its proceedings. The Council may, on the recommendation of the Hon. Secretary, appoint a paid Secretary, who shall assist and be under the immediate direction of the Hon. Secretary and aid him in all matters.

57. The President shall, at the first meeting of the Council after his election, appoint, subject to the approval of the Council, the following standing committees: a Committee on Finance, of three members; a Committee on Papers, Editing, and Publication, of seven Members representative, as far as possible, of the different interests. He may also arrange for temporary committees from time to time.

The President and the Hon. Secretary shall be *ex officio* Members of all Committees. The Hon. Secretary shall be the responsible editor of the transactions, and shall be assisted by an Editorial Committee; the editor of *The Illuminating Engineer*, the recognized official organ of the Society, shall be a member of the Editorial Committee.

PUBLICATION OF PROCEEDINGS &c., OF SOCIETY.

58. *The Illuminating Engineer*, published by the Illuminating Engineering Publishing Co., Ltd., in London, shall be the recognized official organ of the Society, and proceedings and announcements of the Society, &c., shall be published therein, subject to an agreement entered into between the Society and The Illuminating Engineering Publishing Co., Ltd.

59. Papers read or lectures delivered before the Society must not be published in full elsewhere than in the official organ of the Society, without special permission of the Council. Abstracts of lectures, papers, &c., must only be published after the actual date of reading or delivery.

FUNDS FOR RESEARCH, &c.

60. The Council shall undertake, through the appropriate officers as directed elsewhere, the collection of moneys due to the Society, and shall also have power to receive donations for special purposes such as the prosecution of certain researches &c., the organization and support of special courses of lectures on subjects connected with illumination, delivered either under the auspices of the Society or elsewhere as the Council may direct.

The ordinary funds of the society, obtained by subscription, however, shall not be used to prosecute researches or for special purposes outside the recognized scope of expenditure of the Society without the sanction of the Members being duly obtained.

CO-OPERATION WITH OTHER INSTITUTIONS, &c.

61. The Council shall be at liberty to approach or to entertain and, if desirable, accept overtures from other societies and institutions with a view to joint discussions of subjects of mutual interest, exchange of transactions, and co-operation to secure Governmental action, for the advancement of the objects of the Society.

POSSIBLE DISSOLUTION OF THE SOCIETY.

62. In the event of the Society being dissolved the available funds and property of the Society remaining after all liabilities have been settled shall be realized and divided equally between the existing Members at the date of dissolution, or applied to any other purpose that the Council may approve and a two-third majority of the Members at a General Meeting called for the purpose, may confirm.

By-Laws.

APPOINTMENT OF COMMITTEE, &c.

1. The appointment of committees to report upon scientific and engineering subjects shall be authorized only by a majority vote of the Council, which shall be taken by letter-ballot. When such a committee is thus authorized, the President shall appoint the members thereof, subject to approval by vote of the Council.

ADMISSION AND EXPULSION OF MEMBERS.

2. An application for membership to the Society shall be made upon a printed form prepared by the Hon. Secretary, and approved by the Council. which shall call for such information as may be required by the Council to determine the elegibility of a candidate.

3. In the absence of replies from referees to inquiries for information, or if replies are not sufficiently explicit, the Council shall cause the applicant to be notified and shall hold his application in abeyance.

4. The privileges attaching to Membership in the Society shall not be accorded to newly elected Members until they have paid their subscription for the current year. This by-law shall be printed upon the notification of election

5. Upon receipt of an application for membership, which shall be made on the official form, the Hon. Secretary shall see that it has been properly filled up. If not, he shall return the form and notify the applicant of the deficiency. When an application is in proper form it shall be placed before the Council. The Hon. Secretary shall conduct for the Council the necessary correspondence with applicants and their referees.

FEES AND SUBSCRIPTIONS.

6. The annual subscription is payable in advance. Application for subscriptions shall be sent out by the Hon. Secretary not later than January 10th.

7. If the subscription is not paid within one month after a Member has been notified of his election, he shall be communicated with; and if such fees are not paid within three months from the time of notification of election, the Council shall be free to consider the election void. This By-Law shall be printed on the final notice above provided for.

8. From the annual fees paid by each Member 10*s*. 6*d*. shall be deducted and applied as a subscription to *The Illuminating Engineer*, the official organ of the Society, for the year covered by such payment.

9. Any Member whose subscription is six months in arrear, shall be informed of the fact by the Hon. Secretary and shall not receive its transactions or other publications until all amounts due are paid.

MANAGEMENT.

10. The Hon. Secretary shall, after each meeting of the Council, forward to each Member thereof a transcript of the minutes of the meeting, should the Council so desire.

11. Regular meetings of the Council shall be held the third Tuesday of each month, except when otherwise determined. Special Meetings of the Council or of the Executive Committees may be called by the President. Notice of such Special Meetings shall be forwarded to the Members of the Council or of the Executive Committee at least a week in advance of the Meeting. The notice shall contain a synopsis of the agenda to be brought before the Special Meeting, and no business other than that so specified shall be transacted at such a Meeting.

12. Should an Executive Committee have taken any action between Meetings of the Council, it shall report such action at the first Meeting of the Council following; if approved, the action of the Executive Committee shall be regarded as the action of the Council.

13. The accounts of the Hon. Secretary and Treasurer shall be audited annually prior to the Annual Meeting, by the Hon. auditor, or auditors, as directed in Clause 43.

14. The Committee on Papers and on Editing and Publication shall make such revision as may be considered necessary or desirable, of papers and communications offered for publication; in case of such revision the manuscript shall be returned to the author to obtain his consent thereto, and should such consent be refused, the acceptance or rejection of such a paper shall rest with the Council.

15. The Hon. Secretary and the Committee on Editing and Publication may, at their discretion, abridge or eliminate papers or reports of discussions for printing. The Committee shall cancel remarks that do not bear directly on the subject under discussion, or deal in personalities or are otherwise objectionable.

16. All papers, discussions and other matter intended for publication in *The Illuminating Engineer* shall, so far as possible, be revised and edited in manuscript and not in proof.

17. The Council shall have power to make due arrangements for the preparation of stenographic reports of proceedings at the Meetings of the Society, and provide payment therefor.

The Electric Illumination of the Royal Palace in Budapesth.

By Our Budapesth Correspondent.

THE royal palace may be said to be the most important building in Budapesth.

The electrical supply consists of an alternating current 3,000 volt installation, which is transformed down to 105 volts for use. There are three distinct main circuits in the installation, and 210 sub-divisions, supplying in all 10,680 glow-lamps and 60 arc-lamps, and a few small motors, totalling 90 h.p.

The wiring of the building necessitated the laying of 170 kilometres of cable and 100 kilometres of conduit, 3,430 fuses being employed, and 2,250 switches.

The lighting was formerly carried out by means of candles, gas never having been installed. For instance, the main halls were illuminated only a few years ago by clusters of hundreds of candles, lighted simultaneously by sulphur threads.

Electrical illumination was first introduced in 1881, one of the halls being illuminated by means of arc-lamps. The installation was not entirely successful and had its ludicrous side, for it was found that owing to the heating of the wires carrying the current the installation melted and oozed out, so that the counsellors found to their amazement that electricity was not without the inconvenient grease-dropping qualities of the stearine candle. Subsequently 600 glow-lamps were installed in 1891, in the old palace, and during 1897 to 1905, when the palace was rebuilt, the installation was brought thoroughly up to date.

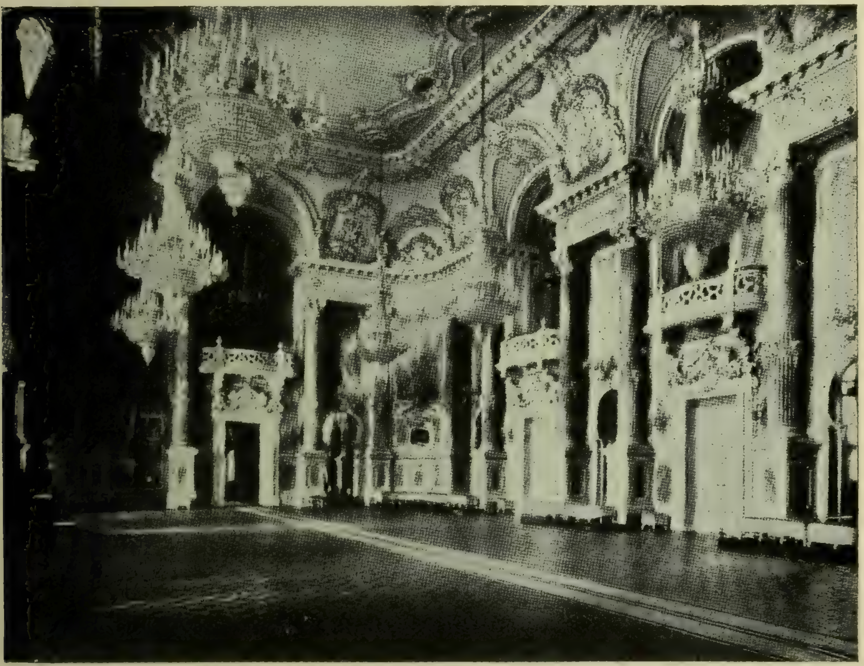


FIG. 1.—Hall in the Palace at Budapesth Illuminated by Candles.

Some particulars of the intensity of the illumination employed in the building may be of interest.

In the halls similar to that shown in Fig. 1, the intensity per cubic metre of space amounts to 3·5 to 7 Hefner candles.

This information is derived from the engineer in charge of the palace on behalf of Messrs. Ganz & Co.—Mr. Abel.

Modern Glowlamps and their Production.

By K. Sartori (Vienna).

(Paper read at he Generalversammlung der Vereinigung oesterreichischer und ungarischer Elektricitätswerke abbreviated.)

The manufacture of glow-lamps constitutes one of the most extensive industries that exist at the present day. Several American journals have recently collected figures relating to the number of incandescent lamps in use per 1,000 inhabitants in many of the largest towns in Europe and the

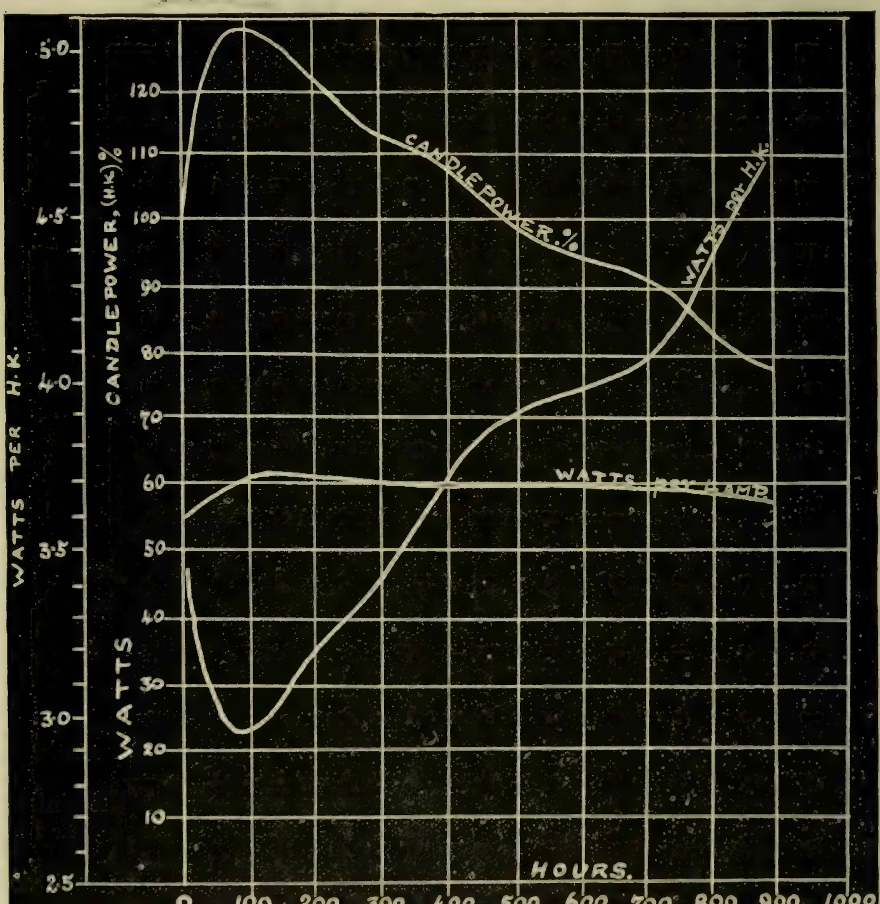


Fig. 1.—Tests on 5 carbon filament "Volta" lamps (110 volts 16 H.K.).
The mean initial intensity was 15·8 H.K.
,, ,, ,, specific consumption was 3·51 watts per H.K.
The mean life was 893 hours.
The lamps burned on 110 volts D.C., and in a vertical position.

United States. The following figures, for instance, have been recently put forward in this connexion :—

Boston, U.S.A.	1232	lamps	per 1,000	inhabitants
New York, „	859	„	„	„
Vienna „	246	„	„	„
Paris „	185	„	„	„
London „	184	„	„	„
Berlin „	176	„	„	„

In spite of the universal application, the manufacture of glow-lamps is still a difficult process. Even in the case of carbon filament lamps the various processes of squirting and flashing require close attention, and have been the subject of countless patents. In the case of metallic filament lamps

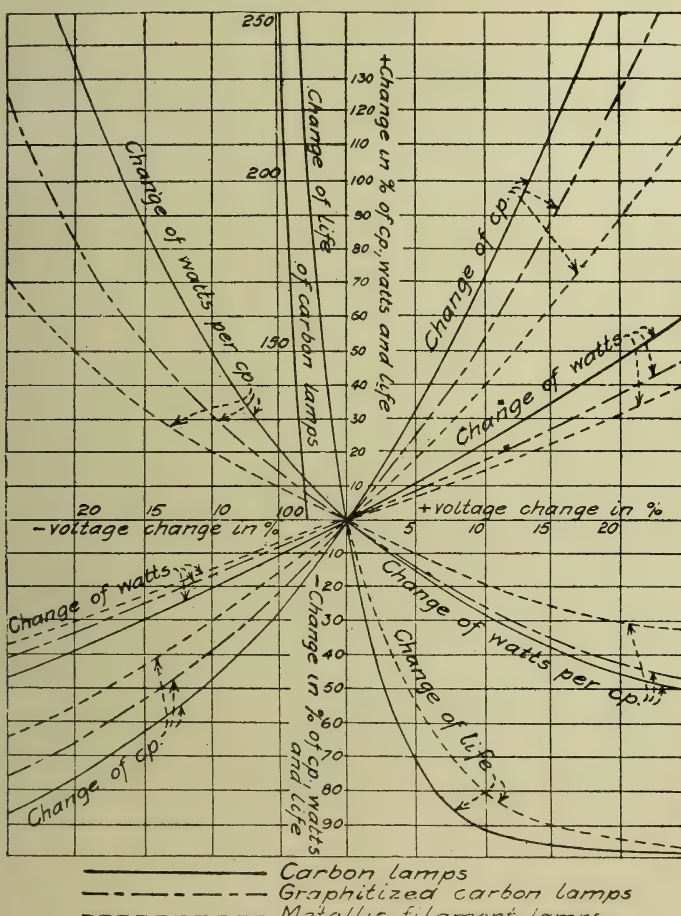


FIG. 2.—Exhibiting general qualities and characteristics of Carbon, Graphitized, and Metallic Filament Lamps.

It is true that these figures are two years old, and the relative values have no doubt changed during these two years. It appears, however, that in America more glow lamps are used, at least in the larger towns, than in Europe, and this seems to be due to the fact that such lamps were introduced into America at an earlier date.

the constant stream of improvement is yet more rapid.

Fig. 1 may perhaps be taken as an example of the performance of carbon filament lamps. These curves refer to an experiment on a series of "Volta" lamps, but this particular make has not been specially selected, but only taken at random as a general example. The

candle-power of these lamps, it will be observed, rises enormously at the beginning of their life—increasing as much as 20 per cent.

Now it is customary to define the "useful life" of lamps as the time taken for the light yielded by them to fall to 80 per cent of its original value. Strictly, however, performances of compare very differently on the basis of the candle-power hours in each case. If, for instance, the curves in Fig. 1 had not risen, but gradually fallen to 80 per cent of the initial candle-power, the lamps would, on the "useful life" basis, be considered equal, and yet the actual light yielded in the latter case would have been greatly inferior.

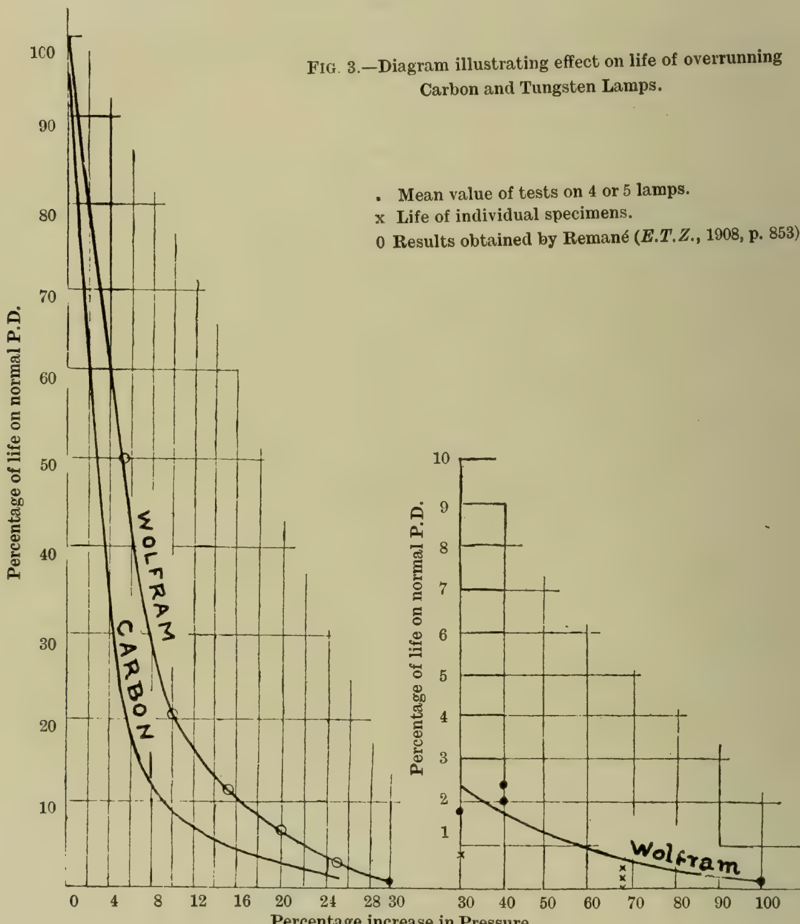


Fig. 3.—Diagram illustrating effect on life of overrunning Carbon and Tungsten Lamps.

lamps are more correct compared by integrating the area of the curve between zero and the 80 per cent limit.

Thus if y, the ordinate, represents candle power, and x the abscissa represents burning hours, the integral $\int_0^t ydx$ constitutes a better measure of the output of the lamp. It is quite conceivable that two lamps which possess the same life, as defined above, might

In England it is customary to estimate the useful life of a lamp as follows. The curve is integrated with a planimeter up to a certain point, and, when the area so determined is 80 per cent of the area of a rectangle constructed by drawing horizontal and vertical lines through the 80 per cent ordinate and the point corresponding to the burning hours under considera-

tion, this number of burning hours is termed the useful life of the lamp.

This is not the continental practice, but I must confess that the English method seems to me the more correct one. Moreover, lamps judged by our method suffer by comparison and the adoption of the planimeter method of determining life is well worthy of consideration.

very marked advantage. For instance, the life of a carbon filament lamp is reduced to only 30 per cent by an increase of P.D. from 100 to 105 volts. The life of metallic filament lamps under the same conditions is only reduced 50 per cent. From the above it will, however, readily be imagined how only a fluctuation of 5 per cent at the central station will lead to

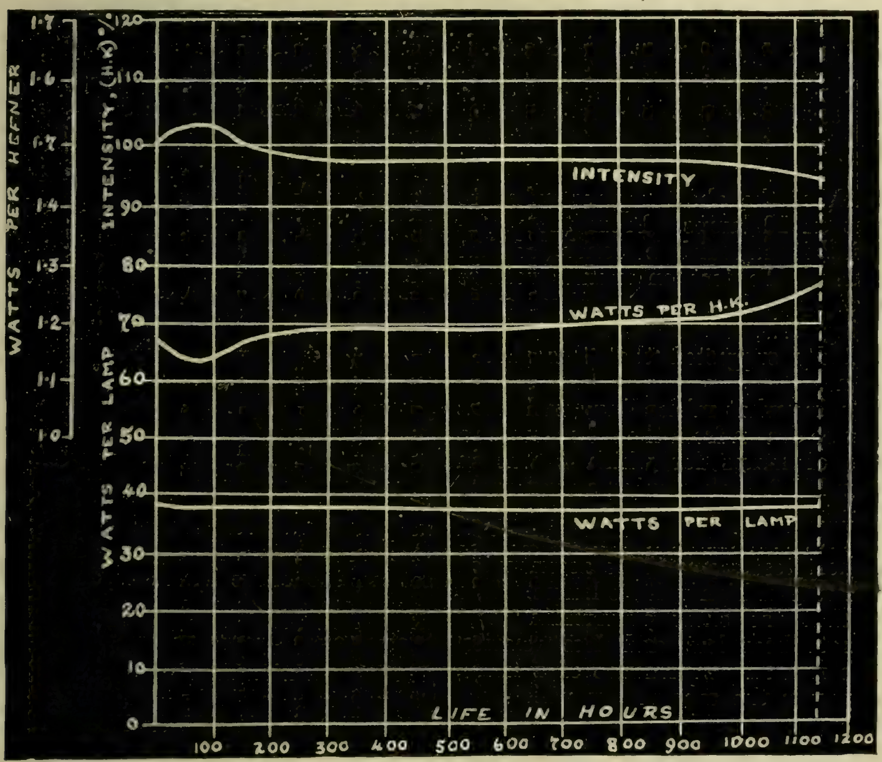


FIG. 4.—Tests on 10 Just-Wolfram Lamps (110 volts 32 H.K.)
The mean initial intensity was 32·3 H.K.
,, ,, ,, specific consumption was 1·18 watts/ H.K.
The mean life was 610 hours.
The lamps were burned in a vertical position on 110 volts D.C.

In Fig. 2 almost all the chief characteristic properties of carbon and metallic filament lamps have been summarized.

It may be remarked that the curves illustrating the percentage change in candle-power caused by a given change in pressure are less steep in the case of the metallic filament lamps. The latter are less affected by fluctuations in the supply P.D., this being a

complaints on the part of the consumer!

This leads us to the consideration of so-called "over-running" tests on lamps, and I must confess that in my experience, such tests have always proved misleading. It is customary, in this connexion, to employ a factor k, denoting the constant by which the short life determined by the method of overrunning must be multiplied

in order to obtain the assumed life on normal P.D. The following is a table of values for k, all referring to the same type of carbon filament lamp :—

VALUES OF K FOR 16 H. K. CARBON FILAMENT LAMPS.

110 volt "B" 16 H.K.	220 volt "B" 16 H.K.
112·0	87·0
52·6	43·3
40·0	123·0
43·0	59·0
41·5	45·4
38·0	38·1
45·4	43·4
50·5	48·0
	44·9
	58·5

Each of the above figures refers to a test on 10 lamps. From the variation in k it may fairly be concluded that the usual life test on normal voltage cannot be replaced by the short overrunning one, although it has been repeatedly suggested that this should be done.

Imagine what misleading conclusions might be drawn from the behaviour of a group of lamps for which k was in reality 123·0, by assuming a previously determined value near 40. It will be observed, too, that the unreliability of the short test seems to be accentuated in the case of high voltage lamps. The fact that the short overrunning test comes to bear less and less relation to the normal performance of a lamp, the greater the amount by which the nominal pressure is exceeded, will be understood from the following figure. The choice of an excess of 20 per cent of pressure is very unsatisfactory, simply because so small an alteration in this value effects the life so enormously. An excess of 10 per cent would certainly be preferable because the gradient of the curve is less steep, and a small change in pressure is not quite so vital.

The above researches have also been extended to metallic filament lamps, and Herr Remané* has recently published results of a similar nature. The figures referring to metallic filament lamps in Fig. 3 are based on a combination of Herr Remané's results and my own.

The choice of the degree of overrunning to which lamps are subjected seems to have been hitherto determined on an entirely arbitrary basis, and I have therefore abandoned it entirely in tests on glow-lamps carried out under my supervision. As explained above, I should prefer to utilize an excess of pressure of 10 per cent, for by so doing the maximum reliability is attained, and, in addition, the "short life" is just one-tenth of that under normal conditions. To the best of the writer's knowledge this result is published for the first time.

As regards the method of plotting such curves it may be suggested that a continuous phenomenon, such as the gradual diminution in candle-power of an average lamp ought to be represented by a continuous curve. For this reason it seems undesirable to set up the curve afresh when a lamp burns out; although this is certainly correct as regards the exact recording of the process of testing it does not adequately represent the behaviour of the lamp in use, and I prefer to draw the curve through the mean points so as to secure a more continuous result. As an illustration of this method take Fig. 4, which represents a series of tests on the improved Just tungsten lamps.

* *Verband Deutscher Elektrotechniker*, 1908.

(*To be continued.*)

Annual Convention of the National Electric Light Association.

THE annual convention of the above association is announced to take place on June 1st, 2nd, 3rd and 4th, at Atlantic City, N.J.

Twelfth Annual Convention of the International Acetylene Association.

THE twelfth annual convention of the above association is to be held in New York on August 9th to 11th of this year.

The Selective Emission of Incandescent Lamps as Determined by New Photometric Methods.

By E. P. Hyde, F. E. Cady, and G. W. Middlekauff.

(A paper presented at the February meeting of the New York section of the Illuminating Engineering Society.)

(*Continued from p.* 339.)

In interpreting the results given in the tables it may be stated that there is relative selectivity among the filaments beyond any doubt, but to what extent the high efficiencies of the metallic lamps are to be ascribed to selectivity and to what extent to the high temperatures at which the filaments operate, is by no means immediately apparent from the data given in the tables. In order to arrive at any definite conclusion in regard to the amount of the selectivity one must know under what conditions of operation the filaments are at the same true temperature, and at present there is no ready means available for making this determination.

If one could assume that when the filaments are at the same colour, that is, when they show the same distribution of energy in the visible spectrum, they are operating at the same temperature, a quantitative estimate of the amount of selectivity would be possible at once, but there is no reason to believe that when the filaments show the same distribution of energy in the visible spectrum, all of them are operating at the same true temperature; in fact, there is much reason to believe that under this condition they are not operating at the same true temperature. By making an assumption which has been found to be true for platinum and which, though probable for most metals, has not been demonstrated to be true, it is possible to form an idea of the direction in which the difference in temperature will occur and to place a lower limit on the effect of selectivity in partly accounting for the high efficiency of the metallic filament lamps.

It will be noted from the data given in Table I. that when the untreated carbon and osmium filaments are at the same colour the lumens per watt of the osmium filament are 1·85 times the lumens per watt of untreated carbon filament. This means that relatively more of the energy emitted by the osmium filament lies in the visible spectrum than in the case of the untreated carbon filament, and that, therefore, the osmium filament is probably radiating selectively in favour of the shorter wave-lengths. The numeral value of the effect depends, however, on the relative temperatures of the two filaments. If they are at the same temperature, the osmium is almost twice as efficient as the carbon lamp when they are both at the same low temperature corresponding to a colour match with the standard carbon lamp when operated at 75 volts. If, on the other hand, the temperature of the osmium filament is higher than that of the carbon filament, then one cannot tell whether the increased efficiency of the osmium lamp is due to its selective emission, or to the slightly higher temperature at which it is operating.

Our knowledge of platinum radiation would lead one to expect, however, that the temperature difference is in the opposite direction. If we imagine a radiating body which tends to exaggerate in its emission the energy of the shorter wave-lengths, that is, a body which emits a larger proportion of its total radiant energy in the visible spectrum as compared with a black body at the same true temperature, it is probable that this property of selective emission would obtain in the

visible spectrum also, so that the emission in the blue would be relatively larger than the emission in the red as compared with the emission from the black body at the same temperature. If this assumption, which would seem to be true for platinum, is true for tantalum, tungsten, and osmium, then the values recorded in the tables give, in every case, the lower limit of the effect of the selectivity on the efficiency of the filaments. For if, when at the same true temperature, the osmium radiates relatively more blue than red as compared with the untreated carbon —considered approximately as a black body—the colour of the osmium light would be bluer than that from the untreated carbon, and it would be necessary, in order to bring the light of the carbon filament to a colour match with that of the osmium filament, to increase the voltage, that is to increase the temperature of the carbon lamp. Such an increase of temperature would increase the lumens per watt for the carbon filament, and if it is found that, even at a colour match, the lumens per watt of the carbon filament are only a little more than one-half the lumens per watt of the osmium filament, it would seem that if the two filaments were at the same true temperature the difference in efficiencies would be even greater. Hence, the numerical values given in the tables would seem to indicate a lower limit to the effect of selectivity on the efficiency. It is impossible to say how much more pronounced the selectivity would be if one could bring the filaments to the same true temperature.

It is possible that the difference between the working temperatures when the filaments are at the same colour becomes more pronounced as the absolute temperature is increased, and that this may account for the smaller differences in lumens per watt at the higher voltages as compared with the results obtained at 75 volts. At all events, one can see from Tables II. and III. that if the assumption contained in the previous paragraph is true, an osmium lamp at the same true temperature as that at which an anchored oval treated carbon filament operates when consuming about 3·1 watts per mean horizontal candle—colour match with standard carbon lamp at about 115 or 120 volts—would show an efficiency higher than that of the carbon lamp by more than 35 per cent or 40 per cent; one cannot estimate how much higher the efficiency would be without a knowledge of the temperature difference which exists between the osmium and treated carbon filaments when at a colour match.

From the data given in the tables for tantalum and tungsten it is evident that for these also, as well as for osmium, the selectivity would seem to play an important part in causing the high efficiency, particularly in the case of tungsten. It cannot be emphasized too greatly, however, that all of the deductions in regard to the effect of selectivity in partly explaining the high efficiency of the metallic filament lamps are based on the single assumption that if a black body and a metal are at such temperatures as to show the same distribution of energy in the visible spectrum—colour match—the temperature of the black body is at least as high or higher than the temperature of the metal. This is true for platinum, the only metal that has been investigated, but the authors cannot say positively that it is true for other metals.

It is interesting in passing to note the red black body temperatures given in the second columns of Tables I., II., and III. The values given in these columns are the red black body temperatures of the filaments when they are at a colour match, that is, when they show the same distribution of energy in the visible spectrum. An analysis of these values in their relation to the other data obtained will be reserved for a subsequent paper of a more detailed character. Suffice it to say in passing that on the basis of the assumption which has been repeatedly stated in the preceding paragraphs, there is obtained a convenient means of getting an upper limit to the true temperature of the radiating filament, just as the so-called black body temperature gives a lower limit to this

value. This upper limit would be the temperature of the black body at which it shows the same distribution of energy in the visible spectrum—colour match—as the filaments under investigation. The experiment of determining this upper limit by the use of an electrically heated black body has been performed at one temperature, namely, that corresponding to a colour match with the standard carbon lamp at 75 volts. As a result of the experiment it has been found that the temperature of a black body at which it has the same distribution of energy as the standard lamp at 75 volts is almost the same, perhaps slightly greater than the red black body temperature of the untreated carbon.

If, then, it be assumed that when at a colour match, all of the filaments are at the same true temperature—an assumption which almost certainly is not true—the value 1420 C. is obtained as the upper limit of the true temperature of the filaments when at a colour match with the standard lamp at 75 volts. In all probability the true temperature in every case will lie between 1420 and the value given in column 2 of Table I. It is possible from the data given in column 2 to arrive at some idea of the emissive properties of the various filaments, but that point will not be dwelt upon in this paper.

Lights of Locomotives and the Eyesight of Engine Drivers.

An interesting investigation has just been carried on by the Great Northern Railroad in the United States, regarding the placing of brilliant head-lights on locomotives. A Bill had recently been introduced requiring locomotives to be supplied with lights of 1500 candle-power, and the question had arisen whether, in the interest of the public, such brilliant lights were desirable.

According to a note in our contemporary, *The Illuminating Engineer* of New York, experiments indicated that the effect on the eyes of drivers of such bright sources was very unsatisfactory. In these tests the engineers were stationed at the end of a track running the full 500 ft. length of the shop of the railroad, at St. Pauls. In front of the engineers the big head lights were arranged and moved so as to reproduce as closely as possible the actual conditions on running locomotives. The colour of these lights was changed from time to time, and the men were supplied with tally-cards, and were asked to mark the different signals as they disappeared.

It appears to have been found that, after a time, exposure to such bright lights interfered with the colour sense of the observers, and it was stated, that after repeated experiences of this kind an engineer might have to retire from the service on account of incipient colour-blindness. In these tests, it is said, no single engineer observed all the signals correctly.

On these grounds an agitation to prevent the Bill in question from becoming law has been begun.

Five Watt Four Candle Power Sign-lamps.

At a meeting of the Electrical Club in Chicago, on Feb. 24th, some details were given of a variety of low-voltage tungsten lamp, specially intended for sign-lighting. The short and stout filaments are stated to be run at an exceptional efficiency. They are run at 9 to 11 volts, usually supplied by the aid of a 10 to 1 step-down transformer; these are frequently mounted on the actual sign to which they supply current.

Although only consuming 5 watts each, the brilliancy of these small filaments is said to give the impression of much larger lamps when viewed at a distance.

The International Unit of Light.

We have received a copy of the published *Transactions* of the Council of the International Electrotechnical Commission, held in London in October, 1908.

Mention of the decisions of the Commission, relating to the International Unit of Light, has already been made in our columns, and we now publish the official account of the resolutions and discussion on this matter, which are as follows :—

The following proposal, put forward by the French Committee, was read :—

" The French Committee recognizing the advantage which would be gained by the international agreement as to the Standard of Light, and seeing that the first investigations with regard to an absolute unit of white light have received official sanction by the decisions of the International Commission on Electrical Units of the 2nd May, 1884, and of the International Congress of Electrical Engineers of the 31st August, 1889, admitting that the present position of affairs in regard to the Unit of Light is similar to that which existed in 1884 with regard to the ohm, desires to put forward the following suggestion :

" ' Whilst awaiting further investigations into the question of the absolute Unit of Light, that for practical requirements a Unit of Light be provisionally adopted under the name of " International Candle," related in the following manner to the various Units at present in use, and which take cognizance of the decisions of the International Commission on Photometry, held at Zurich in 1907 :

" ' 1 International Candle = 0·104 Carcel
" ' 1 International Candle = 1·12 Hefner
" ' 1 International Candle = 0·102 Vernon Harcourt.
" ' 1 International Candle = 0·98 Candle of the Bureau of Standards.' "

In answer to the Chairman's request as to whether the French Delegates desired to add anything further, M. Boucherot replied he thought the proposal was sufficiently definite without further explanation.

The German Delegates were unable to recognize the findings of the Commission on Photometry because the German Electricians who were so interested in the matter had not been present.

M. Boucherot (France) remarked that personally he was not conversant with the subject, but he understood that, as far as France was concerned, the Electricians had been properly represented.

Mr. Gaster said that more than one so-called " international " Commission had been formed to deal with this subject, but they were not international in the proper sense, and he was of opinion that the question of the Unit of Light was a matter which could be eminently dealt with by this properly constituted and fully organized Commission. As, however, in this matter, gas and electricity had to be considered, it was very essential that the Commission should endeavour to come to a proper understanding with the Gas Representatives in the different countries. Personally he took a great interest in the subject and should like to ask Mons. Boucherot as to what exactly was meant by the " International Candle." An International Candle would surely have to be agreed upon by both Gas and Electrical people. He thought that if endeavours were made to this end they would lead to a successful issue, and suggested that the Electrotechnical Committees in the different countries might occupy themselves with this matter.

M. Boucherot (France) was disposed to accept the proposal that no decision be taken at the present time. He made reference to the members who composed the Commission at Zurich as showing that the electricians had not been entirely absent from the Congress.

Dr. Budde (Germany) mentioned a letter, which had been written at the request of the German Committee, asking to be permitted to be represented at the Photometric Congress, which had been replied to in the negative.

Dr. Thompson (Gt. Britain) added that the British Delegates also desired postponement, but for the very curious reason that in England the legal officials, the gas referees, had not been represented at the Zurich Conference.

The French Delegates were thanked for having brought the matter forward, and for being prepared to agree that for the present the matter should be postponed. It was unanimously decided, therefore, that the matter be postponed, but that in the mean time all Electrotechnical Committees be asked to consider the subject in such a manner as to give satisfaction to both the electrical and the gas industries.

The Proposed International Unit of Light.

Memorandum as to Photometric Units Issued by the National Physical Laboratory.

An important announcement with regard to the photometric units maintained at the Bureau of Standards, America, the Laboratoire Central d'Electricité, Paris, and the National Physical Laboratory, Teddington, has been issued by the Bureau of Standards in their Circular No. 15, dated April 1st, 1909.

It was at first intended to make this announcement simultaneously in America, France and Great Britain, but circumstances prevented this. It is desirable, however, to state authoritatively that the agreement described in the Memorandum enclosed has been arrived at and has the approval of the Gas Referees; and that the photometric standards of the National Physical Laboratory are being maintained in accordance with it. *May*, 1909. R. T. Glazebrook, *Director*.

In order to determine as accurately as possible the relations between the photometric units of America, France, Germany, and Great Britain, comparisons have been made at different times during the past few years between the unit of light maintained at the Bureau of Standards, Washington; at the Laboratoire Central d'Electricité, Paris; at the Physikalisch-Technische Reichsanstalt, Berlin, and at the National Physical Laboratory, London.

The unit of light at the Bureau of Standards has been maintained through the medium of a series of incandescent electric lamps, the values of which were originally intended to be in agreement with the British unit, being made 100/88 times the Hefner unit.

The unit of light at the Laboratoire Central is the bougie decimale, which is the twentieth part of the standard defined by the International Conference on Units of 1884, and which is taken, in accordance with the experiments of Violle, as 0·104 of the Carcel lamp.

The unit of light at the Physikalisch-Technische Reichsanstalt is that given by the Hefner lamp burning at normal barometric pressure (76 cm.) in an atmosphere containing 8·8 litres of water vapour per cubic metre.

The unit of light at the National Physical Laboratory is that given by the 10 candle power Harcourt pentane lamp, which was prescribed for use by the Metropolitan Gas Referees, burning at normal barometric pressure (76 c.m.) in an atmosphere containing 8 litres of water vapour per cubic metre.

In addition to the direct intercomparison of flame standards carried out recently by the national laboratories in Europe, one comparison was made in 1906 and two in 1908 between the American and European units by means of carefully seasoned carbon filament electric standards, and as a result of all the comparisons the following relationships are established between the above units.

The pentane unit has the same value within the errors of experiment as the bougie decimale. It is 1·6 per cent less than the standard candle of the United States of America, and 11 per cent greater than the Hefner unit.

In order to come into agreement with Great Britain and France, the Bureau of Standards of America proposed to reduce its standard candle by 1·6 per cent provided that France and Great Britain would unite with America in maintaining the common value constant, and with the approval of other countries would call it the International candle. The National Physical Laboratory, London, and the Laboratoire Central d'Electricité, Paris, have agreed to adopt this proposal in respect to the photometric standardization which they undertake, and the date agreed upon for the adoption of the common unit and the change of unit in America is April 1st, 1909.

The following simple relations will therefore hold after that date :—

Proposed New Unit=1 Pentane Candle.
=1 Bougie Decimale.
=1 American Candle.
=1·11 Hefner Unit.
=0·104 Carcel Unit.
Therefore 1 Hefner Unit=0·90 of the proposed new unit.

The pentane and other photometric standards in use in America will hereafter be standardized by the Bureau of Standards in terms of the new unit. This, within the limits of experimental error, will bring the photometric units for both gas and electrical industries in America and Great Britain and for the electrical industry in France to a single value, and the Hefner unit will be in the simple ratio of 9/10 to this international unit.

The proposal to call the commoy unit of light to be maintained jointln by the national standardizing laboratories of America, France, and Great Britain, the "International candle" has been submitted to the International Electrotechnical Commission, and through it to all the countries of the world which are represented on that Commission.

It is hoped that general approval will be secured, and that in the near future the term "International candle" for the new unit will have official international sanction.

The International Commission for the Standardization of Methods of Testing Petroleum-Products.

The members in the above Commission met in London on May 24th. At the last Conference at Bucharest an International Commission was proposed who should consider :

(1) The unification of international methods for the testing of crude petroleum and its products ; (2) introducing an international nomenclature for all petroleum products ; and (3) assisting in the framing of regulations which shall be international in character, regarding the transport of petroleum and its products, both by land and sea.

Representatives of many European countries and of the United States were present, and the proceedings were followed by a reception, arranged by Dr. Paul Dvorkovitz, at the Criterion Restaurant, W., which was very well attended. Among those present we may mention Dr. David Day (the Geological Survey, Washington), Dr. Ubbelohde (the General Secretary of the Commission), Dr. L. Edeleanu (Bucharest), Prof. Zaloziecki (Lemberg), M. Guiselin (Paris), and other representatives.

We understand that the work of the Commission has proceeded very satisfactorily, and wish them success in their efforts to promote international action in this matter.

The Annual General Meeting of the British Acetylene Association.

The annual meeting of the above association was held at Frascati's Restaurant on Wednesday, May 19th.

The President, Mr. C. Hoddle, read a report of progress during the past year and subsequently described "some results of his personal use of petrol as an illuminant"; with this and other matters discussed on this occasion we hope to deal in our next number.

This was the first occasion that the Association have met under the title above. The dinner held after the meeting was well attended by enthusiastic representatives of the acetylene industry, and all agreed that there was great room for the future development of acetylene especially in the direction of illumination and welding in the oxy-acetylene flame.

Notes on Incandescent Gaslighting.

By Dr. C. R. Böhm.

(*Continued from p.* 328.)

More recently inverted mantles, which are merely impregnated, and therefore well adapted to withstand transport, have come into use. These mantles are burnt off by the consumer himself, who, however, in doing so, is apt to cause a disagreeable odour in the room ; up till now this circumstance has been considered one of the main objections to the domestic use of mantles which have not been burnt off previous to their being sent out. In the manufacture of this mantle the elaborate Terrel process is not utilized, whenever possible very thin Ramie fibre, woven into a loosely knitted skin, being employed. The impregnating fluid and its application to the fabric, are as usually employed with Ramie mantles ; it is only necessary to accentuate somewhat the beryllium constituent.

After the mantle has been attached to the magnesium ring it is stretched to its utmost width with the hand and then packed in a round box. Should it be found possible to get rid of the objectionable smell on burning off referred to above, this new type of mantle would incontestably be admitted to possess signal advantages as regards cost and convenience of transport ; the old standing cause of contention between consumer and supplier—the breakage of mantles in transit—might, by its adaption, be very largely avoided. An additional incidental saving is possible, owing to the fact that the tax on unburnt-off mantles is less than that on those that are burnt previous to their being sent out.

How far it is possible to avoid the smell and fumes caused by burning off mantles completely cannot be said positively as yet, but manufacturers are actively engaged on the solution of this problem. Such unpleasant fumes are at least partially eliminated in the case of the so-called "autoform" mantles, by burning off with gas and on an open tap. Under these conditions the gas flame is said to burn up the badly smelling gases almost entirely. This is the experience of Goldberg (Metallind. Rundsch. 1907, No. 47, Nov. 21). The instructions for the use of this method are as follows :—

The tap is opened and the gas ignited at the base of the mantle (the "Hartalin" mantle is provided with a special kindling thread for this purpose), and the match is not removed until the mantle is burning both internally and externally.

As soon as the fabric begins to glow white the tap is closed. After complete burning off of the mantle the gas is first ignited with the tap only half turned on ; next the tap is quickly opened to the full, and the gas is allowed to stream in unchecked. It is then seen that the mantle adapts itself to the shape of the flame, and after a very short time the condition of maximum illuminating power is attained. In technical circles people are too often inclined to ridicule the latest novelty without really testing its merits : this attitude was in this case a most mistaken one.

According to the new British Patent Act of 1902, which came into force on January 1st, 1905, all applications for a patent are tested with regard to their novelty, by comparison with those of the last fifty years. Yet the Controller of Patents has not the right to refuse a patent even when, in his opinion, its validity is entirely destroyed by the existence of patents of an older date on the same subject. On the other hand he is empowered to direct that certain claims, obviously in conflict with older patents, shall be deleted

from the specification, before the application is granted. This law is naturally a defective one, because the courts are eventually left to decide upon the validity or otherwise of a patent, and whether or no it is wholly or partly dependent upon older claims, just the same as before this Act existed, and as is the case to-day in countries where no examination of patents is enforced. It is well known that patent litigation is very costly, and on this ground alone, applicants will usually abstain from going into court.

In order to guide the reader in following this discussion of technical processes, such as the Cerofirm and Plaissetty, the author has thought fit to give the above brief résumé of the Patent laws in England and Germany. The new Cerofirm patent (2240/08) was applied for on January 31st, 1908, and granted on November 26th, and may therefore claim priority over that of Simonini (10233 of May 11th, 1908). The claims of the Cerofirm Co. are as follows :—

"Process for the manufacture of incandescent gas mantles, characterized by the treatment of fabric impregnated with incandescing salts, with a solution of hydrogen peroxide, containing a proportion of such materials as, either above or in conjunction with the hydrogen peroxide, transform the cerium into a compound which is insoluble in water, without, at the same time interfering with the formation of a corresponding insoluble compound of thorium."

In the case of the Plaissetty patent a second direction was given, namely to subject the impregnated artificial silk mantle to immersion in a bath which converts the incandescing nitrate material into colloidal compounds, such as are insoluble in water. This process, however, must be presumed not to apply to the treatment of the actual fibres, for colloidal solutions are not taken up by the colloidal artificial silk. Although it has more recently been proposed to employ colloidal solutions for the purpose of impregnation, there is reason to fear that not sufficient incandescing material would be taken up in this way. Moreover, according to G.P. 188,427, hydrogen peroxide alone could not be expected to act as a "fixage," as I term this bath, for it only converts thorium into the colloidal state and leaves the cerium unchanged.

The great advantages which hydrogen peroxide possesses as a "fixage" only appear in the latest patent of the Cerofirm Co. in Berlin and London. Now, since hydrogen peroxide exercises no effective action on the cerium, one would be compelled to introduce empirically determined mixtures into the "fixage" or the impregnating solution. When one considers how greatly the colour and intensity of the light derived from a mantle are affected by small variations in the percentage of cerium, one can easily see that it is impossible to make a practical and uniformly incandescent mantle in this way. The amount of the cerium constituent available must be different in the portions of the bath coming in contact with different portions of the fabric immersed in it, and therefore the percentage of cerium in different parts of the mantle will also eventually be found to vary. This far from inconsiderable difficulty is completely avoided in the new patent of the Cerofirm Co., who add to the hydrogen peroxide other substances which hydrolize the cerium, and transform it into a condition insoluble in water, without hindering the action of the hydrogen peroxide on the thorium.

This property is possessed by certain bases, weak acids, and their salts. Bases are known to convert the incandescing salts into hydroxides which, after being brought to the glowing state, yield a hard granular surface of oxide. But practical experience has shown that a high intensity and efficiency is only derivable from mantles made from thorium nitrate, which, after incandescence, leaves a fine and soft oxide behind. Apparently the heat of the ordinary bunsen flame does not suffice to raise the temperature of the relatively large and coarse particles of oxide, derived from the hydroxide, to a sufficiently high value. In any case it is a fact that the Plaissetty mantles possessed a relatively low illuminating power, yielded light of a

yellowish tint, and consumed a comparatively large amount of gas (about 140 litres per hour), while the new Cerofirm process enables mantles to be produced which, in addition to their elastic qualities show a great improvement in the above respects. This is probably to be ascribed to the fact that, in this process, not the simple hydroxide but higher hydroxides are formed, which on burning leave a finely divided, soft ash behind.

In considering the effect of weak acids and their salts, attention must first be given to organic materials. For instance, it is well known that alkali acetates, in presence of hydrogen peroxides, separate out the cerium as a compound which will not dissolve in water; by the aid of this sensitive reaction, the presence of 0·01 mg. of cerium can be detected. Since the treatment of the thorium is not impaired by the presence of this reagent one can conveniently make use of the addition of the acetate, in order to make a homogeneous incandescent mantle.

In the same way the presence of lactic acid gives rise to aqueously insoluble compounds of cerium, thorium, and other rare earths. While formic acid only precipitates the rare earths from solutions in the weaker acids, such as acetic acid, its salts exhibit an action on all solutions; malic, valeric, and other acids behave in the same way. As in the case of the acetates, it is essential, as far as possible to avoid the presence of free acid, and it is also advisable only to select those bases, the salts of which can be easily removed from the fabric by washing and by subsequent incandescence. Compounds of ammonia are to be recommended, provided they do not interfere with the reaction.

The essential principle of the method, namely the hydrolysis of the cerium by the addition of suitable substances, combined with the simultaneous formation of insoluble compounds of thorium, has been dealt with above. Yet the precipitation of the thorium is really somewhat hastened by this addition—a matter of some importance in so far as it might result in a not inconsiderable amount of thorium being extracted; on this account it is advisable to work with very dilute solutions and to use the fixing bath several times. Naturally this is not without influence on the cost of the process.

Since the fundamental work of Van Bemmelen on the subject of colloidal chemistry, it has been recognized that the oxyhydrates termed "hydrogels," occurring in many of these chemical processes, behave themselves rather as intimate mixtures than as true chemical compounds, which resemble solutions and yet differ from them in some respects. In order to describe this special form of combination between two substances, which is not, strictly speaking, either a chemical combination or a solution, Van Bemmelen employed the term "Adsorbtion-compound." The hydrogels of the heavy metallic oxides such as zirconia, thoria, &c., and other hydroxides of rare earths are regarded as "Adsorbtion-compounds" of the particular oxide with water, to which no definite formula can be assigned.

Hauser has applied his observations of the power of absorbtion of the hydrogel of zirconium hydroxide in order to explain the separation of cerium. The correct formula representing the cerium hydroxide is, however, a matter of some doubt. It may be noted that the absorbtion of salts in solution is often accompanied by the formation of a hydrogel, such that the alkali is held fast and the acid component set free.

Naturally the colour of the mantle is very materially affected by the solutions and reactions employed. While a very dilute solution of cerium in hydrogen peroxide gives rise to a deep red-brown precipitate, when acted upon by ammonium or sodium acetate, the thorium solution, when 1 per cent of cerium is present, merely gives rise to a bright yellow colour. The higher oxides of thorium are only with difficulty soluble in dilute acids, yet it is desirable to make use of a bath exhibiting these qualities.

Thorium superoxide attaches itself to the colloidal artificial silk fabric, and enters into its interior much more

satisfactorily than the simple hydroxide and, in addition, leaves a very fine, soft oxide behind on incandescence, which, as we have seen is preferable to a nobby and hard oxide. These two qualities explain much of the improvement of the Cerofirm mantle over the old Plaissetty one.

Cerofirm mantles, obtained by this new hydrogen peroxide method, exhibit the same good elastic qualities characteristic of the Plaissetty mantles, prepared by the ammonia process, but exhibit an improved luminous efficiency, and yield a whiter quality of light. The cost of manufacture of such mantles is also very reasonable, and the process seems to offer a means of avoiding the threatened Ramie monopoly.

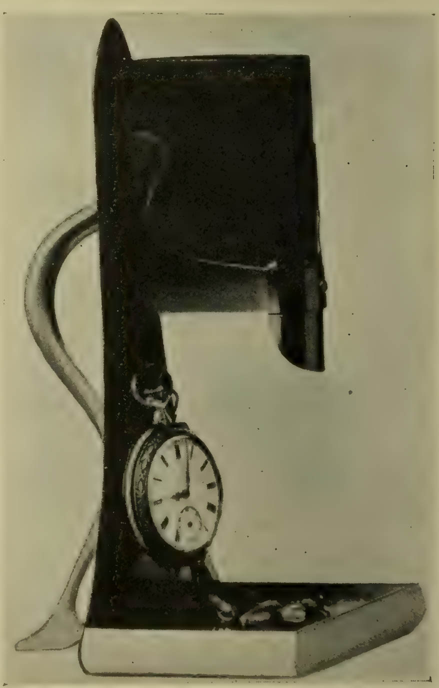
(*To be continued*).

A Simple Apparatus for Illuminating and Displaying of Watches.

A German correspondent sends us some particulars of a simple apparatus which is being used by jewellers in Germany for the display of watches, &c., in their windows. Its nature will be understood from the accompanying illustration.

The watch is put into position at the base of the arrangement, and is illuminated by the rays from a small glow lamp, shown at A, and, it will be observed, thoroughly screened from the eyes of those looking in at the window. This glow lamp is lighted by current from a small portable accumulator resting in the vessel above the watch. A push-contact, in circuit with the cell and the lamp, is let into the platform on which the accumulator rests, but the weight of the latter is not sufficient to press the contact home. In order to do this a small additional weight must be put on, or the slightest pressure of the hand is sufficient to make the contact temporarily and illuminate the watch. This method has the advantage that there is no necessity to feel for the switch, and the jeweller can light up an individual watch just as long as suits his purpose.

The method is specially well adapted for the provision of strong local illumination, in order to draw attention to any particular object in a shop window. This is often desirable in addition to the main general illumination



Intrinsic Brilliancy of Glow-Lamp Filaments.

In a recent paper before the Franklin Institute, G. Loring gave the following figures for the intrinsic brilliancy of various lamp filaments :—

	Specific Consumption.	Intrinsic Brilliancy.
Carbon	3·1 watts per candle	480 C.P. per squ. inch.
Gem	2·5 ,,	625 ,,
Tantalum	2 ,,	750 ,,
Tungsten	1·25 ,,	1000 ,,

The Nature and Position of Artificial Sources of Light in Beautiful Interiors.

THE illustration accompanying this note represents the chimney piece intended for a hall or drawing-room, the Austrian oak panelling being executed by Messrs. Hofler, Ltd., to whom we are indebted for the use of this block.

It will be observed that the effective appearance of the columns on either side of the fireplace, and probably, too, the charm of the interior as a whole must be dependent upon the way in which the light is distributed. Thus rays coming from the left, as furnished by the daylight in this case, throw soft and yet sufficiently marked shadows such as allow the contour of the mouldings, &c., to be clearly seen. On the other hand, a diffused and "shadowless" system of artificial illumination would probably be deemed quite out of place from the artistic standpoint.

When the artistic appearance of an interior is of consequence, the scheme of artificial lighting adopted is very

vital. The sources of light, one would suppose, would be largely chosen for their intrinsic artistic value and power of showing up surroundings, as distinct from the mere provision of light necessary for reading, &c., and their position would be mainly determined by the same considerations.

The sources shown in this illustration hardly seem to comply with these conditions. Clearly the two imperfectly shaded lamps installed will give rise to conditions of illumination very different from those characteristic of the daylight. The direction of the light is entirely altered, and the fact that it comes from such concentrated sources will probably produce a very different variety of shadows.

In addition one would suppose that, on artistic grounds alone, the use of imperfectly screened bright filaments of glowlamps would be open to objection in interiors of this kind.

To sum up, it seems reasonable that the consumer, after taking pains to secure a beautiful and charming scheme of decoration in a room, ought also to endeavour to employ sources of light which are not only in themselves in harmony with the surroundings, but also lend themselves to exhibit them to the best advantage.

Testing the Air in Workshops and Factories.

In the May number of *The Illuminating Engineer* for this year special attention was devoted to the report of the Conseil d'Hygiene de la Seine, on the lighting of factories. Naturally in discussing this question the connected subject of ventilation is bound to receive consideration, and some of the report in question is taken up by recommendations on this point.

The progress of the scientific study of ventilation may, perhaps, be regarded as in some respects analogous to the development of methods of specifying the conditions of illumination in workshops, &c. At one time the idea of recommending exact tests of the air in such buildings would have been derided, but it is regarded in a very different manner to-day. A recent paper by Mr. W. J. A. Butterfield, read at the meeting of the Society of Public Analysts on May 5th is of interest in this connexion. Mr. Butterfield explained how a sample of air was sucked into a small botttle on the spot, a stopper rapidly inserted, and the bottle sealed with a rubber band. Such bottles are then packed into suitable boxes and sent to the laboratory in order that the sample of air enclosed may be studied; it was stated that such boxes could be sent through the post with perfect safety, and that on the average only 4 in every 1,000 of these samples did not arrive in good condition. Mr. Butterfield also demonstrated how the contents of such bottles could be tested for the carbon dioxide present, and exhibited a convenient portable Haldane apparatus for carrying out this determination; the mean error was stated not to exceed $\pm 0{\cdot}2$ parts of carbon dioxide per 10,000 parts of air. An interesting detail in this connexion was the provision of an adjustable white background at the back of the box containing the apparatus. This could be folded back and illuminated by a table lamp, and then formed a brightly illuminated surface, against which the graduation on the measuring tube, and the level of the liquid included therein could be clearly seen.

Other apparatus for the complete analysis of samples of air including the determination of moisture and oxygen, &c., were shown, and also a method of estimating firedamp, in mines, &c., by drawing the air over a spiral of platinum wire.

The Special Testing of Petroleum Intended for Use with Incandescent Burners.

By Dr. C. Charitschkoff
(Grossny, Russia).

The incandescent petroleum light has proved of very considerable value in cases where a cheap form of illuminant of high intensity and independent of piping of special plant is desired.

The qualities of this kind of lamp also render it specially serviceable for railway station lighting and for outdoor use in remote districts where high candle-power is required, but where the local conditions render it difficult or expensive to lay cables or piping. Many of the towns in the northern and southern regions of the Caucasus, such as Grossny, Kisslovodsk, &c., now make extensive use of incandescent petroleum lamps. As an example of the usual construction of such lamps in Russia, not differing widely in principle from those of the Kitson and other types, mention may be made of the Galkin "Rossya" lamp, which is quite automatic in its action, the petroleum being forced into the burner by air-pressure, and subsequently vapourized by the heat of its own combustion.

In spite of the recent progress in petroleum incandescent lighting, and its undoubted merits as a means of illumination, there is one question connected with its use that still requires further and closer consideration. Petroleum intended to be burnt in incandescent lamps ought to be subjected to special tests of quality previous to use. The burning of hydrocarbons in the incandescent lamp it may be pointed out, seems to take place under conditions quite distinct from those characteristic of the ordinary wick lamp; therefore all ordinary varieties of petroleum for illuminating purposes are not equally well adapted for use with incandescent burners.

This suggestion I can substantiate by reference to a practical case that came under my notice. A certain railway in Southern Russia, had utilized the "Meteor" petroleum for their incandescent lamps. After the substitution of ordinary illuminating petroleum, however, charring and choking occurred in the vapourizing chambers, and there were many complaints. The "Meteor" petroleum, on the other hand, is a variety possessing qualities which render it pre-eminently suitable for use with lamps of this class.

The chief properties which petroleum must be proved, on testing, to possess are as follows:—

Specific gravity, not more than 0·825 at 15° C.

Flashpoint (specified variously in different countries, for instance, in Russia, 28° C., in Germany 22° C., &c.).

Colour Grade, 2½ according to Stammer.

Petroleum must also undergo refining processes with sulphuric acid and caustic soda. Naturally compliance with these requirements, however desirable in the case of oil for ordinary purposes, is not so essential in the case of oil intended for the incandescent burners. The most important qualities of oil for this purpose are constancy of chemical composition, ability to withstand decomposition, and absence of tendency to char when heated to temperatures above the boiling point. Flashpoint is only of importance in so far as it furnishes an indication of the chemical constancy of the petroleum, and of the feasibility of vapourizing it under pressure.

The colour and lightness of the petroleum are also of small importance. For instance in my researches I

obtained a yellow variety of oil by the dry distillation of Grossny residues, which was very suitable for incandescent burners, and "Meteor" has also been shown to be well adapted for this purpose.

In order to test the constancy and power of withstanding chemical decomposition of different varieties of petroleum, during vapourization, I have designed a special form of apparatus, which I termed a "Kerosinometer." This consists essentially of a retort from which the petroleum vapour is distilled and driven through a long tube, being subsequently condensed. The tube referred to is heated in a sandbath to a temperature of about 300° C. The extent of the layer of carbon deposited on the interior of this tube furnishes a measure of the constancy of the petroleum vapour when vapourized.

By this means I have tested more than forty varieties of petroleum, and studied their relative behaviour under conditions resembling those which prevail in the petroleum incandescent burner. Different qualities of oil give rise to very different results, but it may be remarked that their behaviour from this standpoint is in no wise connected with their ordinary normal qualities in other respects.

The High Pressure Inverted Gaslighting of Fleet Street.

In these columns attention has previously been drawn to the lighting of Fleet Street by means of high pressure inverted Keith lamps. The lighting of the streets of European cities by high pressure gas has been familiar to us in Europe for some years, but the inverted high pressure system is of more recent introduction. Very excellent results are, however, said to have been achieved in this way in Berlin, and the display of a large number of these lamps at the Franco-British Exhibition in London last year attracted much notice.

Since that date the same system has been applied to Fleet Street, as will be seen from the illustration on the opposite page. These lamps, it will be recalled, are worked at a pressure of about 54 in. of water, and are credited with an intensity of about 1,500 candles and an efficiency of 60–70 candles per cubic foot of gas. An interesting feature of the system has been the suspension of the lamps from brackets at the side of the street, instead of their erection on lamp posts—a method of avoiding obstructions in the street somewhat analogous to the hanging of arclamps on wires spanning the roadway adopted in Cannon Street, in London, and the Friedrichstrasse in Berlin.

This development should be of special interest to engineers in the United States. High pressure gaslighting, which, it is stated, has not yet made much progress in that country, is now receiving close attention, several well-known gas and electrical experts having recently visited Europe with the object of studying this and other systems of street lighting.

Public Lighting in Boston.

We observe, in a recent number of *The Electrical World*, that the Mayor of Boston has just signed a new five-year contract with the Edison Electric Illuminating Company for street lighting. The contract calls for the payment of $380,000 a year and may be extended by the city to a period of ten years. If a ten-year contract is entered into the price is only $360,000 a year. A board of arbitration is provided which will consist of the scientific heads of Harvard and the Boston School of Technology, together with a third whom these two arbitrators will choose.

Illumination of Fleet Street (London) by the New Inverted High Pressure Incandescent Gas Lamps.

[For the use of this block we are indebted to the courtesy of the *Journal of Gaslighting*]

Some Effects of the Reflecting Power of Surroundings upon Ground Illumination.

It is now quite generally appreciated how very considerably the scheme of decoration in a room affects the available illumination. It is, however, possible that the logical result of utilizing such dark surroundings may even be virtually to destroy the effect of the light supplied. For if a source of light is intended to enable a person seated at a table to read a book, it may be an easy matter to provide an adequate direct illumination on the book itself, and yet, if the surroundings are of a very dark hue, it may be very difficult ever to achieve sufficient general brightness. Hence the eye, when glancing up from the book is constantly annoyed by the sharp contrast between the illumination of the book and the dark background.

In the same way it may be pointed out that if a newspaper is printed on some dark-hued or coloured paper that reflects but a fraction of the light falling upon it, it becomes proportionately hard to read; an order of illumination which is ample for a good white page may then become quite inadequate.

Again, in the case of the room cited above, in addition to the drawback already mentioned, there is the further objection that, when all surroundings are of a uniformly sombre tint, it becomes correspondingly difficult to find one's way about, even though powerful lights are employed. The griminess of the surroundings renders it very difficult to provide a good general illumination in many factories

The same holds good to some extent of much street-illumination. In a dark country road, it would often be no easy matter to produce an impression of satisfactory illumination however excellent the illuminating power of the sources provided, merely because the light produced is all swallowed up by the surroundings. Consequently the main value of the sources employed is as "beacon-lighting," and a street consisting of grimy buildings, and dirty pavements is correspondingly hard to illuminate. The writer was struck by the impression of improved illumination in many of the streets of London during the early stages of a snowfall last winter, and before the white surface of the snow had been converted into coffee-coloured mud. London, however, is at a disadvantage in this respect compared with such cities as Cape Town, where, Professor Bohle has remarked, the prevailing whiteness of the buildings is of considerable assistance to the lighting expert. An excellent illustration of the diffusing power of such surfaces was to be seen last year at the White City.

One rather interesting example of this effect comes up when we consider the illumination of the threshold of a building or door. The expression "Mind the step" has become proverbial. It is true that in many such cases no adequate illumination is provided. At the same time it is not unlikely that very often no reasonable illumination could make the step sufficiently prominent, simply because it is so similar in shade to the surroundings. The complaint of "poor light" over the doorstep is much less likely to be heard when the step is white and is maintained so. In the same way the whitening of the extreme limit of railway platforms, &c., is an excellent practice, quite as effective for its purpose, as the provision of proper lighting.

Such details may be considered trifling. They illustrate, however, a side of problems in illuminating engineering for which the lighting engineer may not be responsible but which may, nevertheless, affect very materially the success of his design.

Porch-Lighting.

By an Engineering Correspondent.

The main object of a light outside the hall door of a residence is usually to light up the steps so as to prevent any one stumbling, and also, perhaps, to enable those within the house to see the face of people outside before they are admitted.

This last consideration is often of some moment in country districts, where tramps are a nuisance, and it is worth while to point out that the position of the lamp in this case requires a little care ; otherwise it will actually prevent the accomplishment of the very object for which it is installed. If, as often happens, the glow-lamp is hung immediately outside the door, so as to be in the line of view of a person looking out from the brightly illuminated interior, it merely makes it impossible for him to see anything outside at all. If, however, the lamp is concealed so that he only sees the objects illuminated by it, it serves its right purpose.

The illustration accompanying this article shows one form of porch lighting which doubtless has some drawbacks, but, is, at any rate, an illustration of the *principle* on which such lights should be installed.

It will be seen that the sources are quite out of the field of view, being placed in the cornice well above the top of the door. They consist of tubular lamps with reflectors, so as to concentrate the light downwards, and also throw a certain amount of light on the white surface above the door, which, therefore, assists in promoting the general diffused illumination.

The photograph, however, scarcely does justice to the intensity of the illumination on the ground, which in this case amounted to about 0.5 candle-feet.

The light was provided by two 8-candle-power lamps, distant about 8 feet from the ground, but the reflectors and the diffusing white surface enable the greater part of the light, which would otherwise be thrown above the horizontal, to be effectively utilized.

The method shown in the illustration above, besides apparently complying with the utilitarian aspects of the problem seems to the writer to be preferable from the artistic standpoint.

Fig. 1.—Porch-Lighting by Concealed Lights.

Certainly, the general effect produced by the illuminated white moulding, lighted by the concealed sources above the door, is more interesting to the eye than the mere exhibition of an unscreened glow-lamp filament, which is too often considered all that is necessary.

Light Tinted Symbols on Dark Back Grounds in Printing.

By Albert J. Marshall.
Chief Engineer, Bureau of Illuminating Engineering, New York.

Custom — common usage — is something which every new idea and thought must battle with and overcome before recognition of a broad and public nature can be hoped for. Even in this day of wonderful scientific achievements and most painstaking research work, we, in many instances, take too much for granted and our impressions prove, upon investigation, to be quite incorrect. An example of such usage, to my mind, is the common method of printing in use at the present day, black lettering on white surfaces being the general rule.

The use of black lettering on white surfaces, has been handed down to us from past times, until we have come to look upon it as something that is, in the nature of things, correct, and therefore permanent. The use of this method was, in all probability, brought about by the fact that it was an easier matter in the olden days to make a marking fluid which was of a black or dark nature than it was to produce a similar light fluid. With the advent of the printing press and the use of type, further use of dark fluids was made, this time by what we know as ink, which we usually consider as being dark or black; hence the expression, "as black as ink." So far as the writer has been able to ascertain, there appear to be no scientific, physiological or hygienic reasons why the present day method should ever have been put into use, other than those stated above, nor why it should remain.

The question may be raised, what method or system do you advocate in preference to the present day one and why? To this I reply that I am thoroughly convinced, through experimental work which I have conducted for several years past, and on the basis of a knowledge of the theory of vision, that the method of using *light tinted* symbols on *dark* back grounds in printing is preferable, in many ways, to the present method of *black* on *white*. I may call attention to the fact that I recommend *light tinted* symbols on *dark* back grounds, and not *white* symbols on *black* back grounds, inasmuch as in the early stages of my experimental work I convinced myself that *white* on *black* was not only unnecessary, but, indeed, rather injurious to the eye, because the contrast was (and is) too great. This statement, however, does not hold for display work when oftimes severe contrasts are desirable. I have experimented with a large number of combinations of tints, shades or colours in the use of the *light tinted* symbols on *dark* back grounds theory, but the most generally satisfactory combination that I have thus far been able to obtain, is amber or yellow *tinted* symbols against a *dark* shade of green back ground. Yellow is perhaps one of the most acceptable colours to the eye, coming as it does in the middle of the spectrum, while green surfaces, we feel, which are used so generally in nature, serve the purpose of resting the eye. I am, however, not prepared to state that the combination mentioned is the best possible one, for my investigations and experiments in this direction are as yet incomplete.

In advancing and advocating this theory, I fully appreciate the fact that it would be absolutely wrong to put it into general use on the spur of the moment. The eye, having become (forcibly) accustomed to the present method, would not be able to adjust itself rapidly enough to the proposed system, and thereby appreciate its merits; but with a slow process of evolution, which I am firmly convinced will be brought about, the eye will naturally adjust itself to the changes,

and benefit accordingly. This will explain, to a considerable extent, why even a good example of the proposed method appears, at first glance, somewhat confusing. Usage will obviate this confusion.

The theory underlying the proposed method is summed up in the following simple manner. It is common knowledge that in order to "see" an object light-rays must be reflected from this object to the retina of the eye. Therefore, when we look at a page of printed matter executed according to the present method of black on white, what we actually "see" is the white or light *back ground* and (*indirectly*) the letters purely and solely by contrast, inasmuch as the white or light back ground reflects the greatest percentage (percentage reflected depending upon the reflecting or absorbing properties of the surface in question) of the light rays to the retina of the eye, while the printing, done in black, may be considered as absorbing all light rays falling upon it. It will therefore be understood that in order to "see" our present style of printing, the eye must receive light rays from the page as a whole, the size or area of which is usually many times greater than the combined area of the type, *minus* the rays absorbed by the type—thereby stimulating the eye far beyond what is necessary or right. With the proposed method, the eye "sees" exactly that which it looks at—*not the back ground*—for the *light tinted* symbols *themselves reflect* the light rays to the retina of the eye, while the *dark* back ground *absorbs* the greatest percentage of the light rays falling upon it.

This condition of things, perhaps, may be likened to those existing in a jeweller's window, where the bottom, we will say, is covered with black velvet (absorbing, when clean, approximately 99 per cent of all light rays striking its surface), on which is displayed jewellery and precious stones, &c. When you look into such a window, you are not greatly interested in the black velvet back ground, but in the goods displayed thereon, which for our purpose may be considered analogous to printing. Yet another simple and familiar illustration is furnished by the method of writing with white chalk on black-boards, as customary in public schools. It is a comparatively easy matter to "see" writing done in such a manner.

In my experimental work I have attacked this theory primarily from the physiological standpoint. My knowledge of the purely practical and economical side of printing and the manufacture of paper is rather meagre. It may, however, be of interest to observe that this theory seems to offer a possibility of saving forests from their approaching total destruction. Trees are being cut down by thousands and thousands each year to manufacture paper that is chiefly used for the printing of newspapers. Newspaper once used, as at present, is of little or no value for printing again, inasmuch as the ink used thereon is composed of oils and gum, and resists all bleaching process. With the use of the proposed method, namely, *light tinted* symbols on *dark* back grounds, newspapers could be used over again, perhaps many times, inasmuch as they would not have to be bleached, owing to the fact that we should require them in dark shades or colours. It appears that it has been a somewhat difficult matter to obtain highly satisfactory light or white inks, but I feel that this difficulty could and would be overcome if the demand were sufficiently great. It has, however, been suggested that our printing will, in the future, be done by electricity, thus avoiding the use of ink.

A study of the statistics bearing upon the alarming increase of defective eyesight of recent years should also incline one to look favourably upon the proposed method. For instance, in Vermont, 34 per cent of the eyes of the school children examined were found to be defective. In New York City, 17,938, out of 58,948 examined, or about 30 per cent, had defective vision. Dr. Hermann Cohn of Breslau, found that defective vision was becoming more prevalent with the increasing tax on the eye by more study. Among pupils who had remained at school the full fourteen years, 63 per cent had

defective eyesight. Dr. Macmillan Bondi has quoted similar high figures.

While, of course, defective vision is largely due to the wrong use of natural and artificial light, both in schools and at home, yet I am thoroughly convinced that many cases of such defective vision could be materially eliminated by the use of what seems to be a reasonable method of printing. This can be the better appreciated when one considers the amount of study that the ordinary school pupil is supposed to undergo, during which the eye is usually compelled to look, for a long period of time, at comparatively large white surfaces in order to "see" common print. Until the method of *light tinted* symbols on *dark* backgrounds can be put into use, it seems that we can, at least in school books and others of similar type, get away from the use of white paper, which ordinarily reflects more light to the eye than is necessary,* and use in its place a matt surfaced paper of an amber, yellow, green, or some other acceptable shade. This, I think, is the lesser of the two evils, inasmuch as we must use, temporarily, black or dark symbols on white or light back grounds. The solution of the difficulty, however, I think, lies in the complete adoption of the method discussed above.

While the general subject of printing is under discussion I should like to call attention to the very valuable research work that Prof. Robert M. Yerkes of the Harvard University has conducted with reference to ascertaining the proper character and size of type that should be used in printing. Prof. Yerkes, as I understand, is of the opinion that a little experimentation with the design and use of type might lead to radical changes. This, however, is a subject in itself, but it all tends to show how unwise it is to take too much for granted.

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* Table of approximate co-efficients of diffused reflection.

Nature of Surface.	Per Cent Reflected.
Mirror	95
White Paper	80
Glossy Black Paper	5
Dead Black Paper	1
Emerald Paper	18
Dull Green	9
Light Yellow	51
Deep Yellow, buff	41

Fantastic Lamp Shades and Illuminated Clocks.

JUDGING from a recent number of *The American Gaslight Journal*, the design of curious patterns of lamp shades seems to be receiving much attention in the United States. Apart from their primary function of screening and diffusing the light, such semi-transparent shades may serve as oddities or decorative objects. It is becoming customary to exercise some ingenuity on the patterns on the glass, which are illuminated by the light inside, and to add appropriate mottos, illustrations of well-known incidents, &c.

Shades are even made in the form of animal oddities — lobsters, spiders, beetles, &c., the eyes of which, needless to say, are made to glow with an uncanny radiance by the aid of the incandescent mantles or electric light inside. Quaint objects of this kind also serve the purpose of attracting notice in shop windows. For instance, the lighting up and extinguishing of the glowing eye at frequent intervals in itself attracts notice.

Another direction in which the specialized use of the light in the home has been developed is that of the illuminated clock. It appears that householders are now utilizing local illumination for the purpose of lighting up clocks, the light being kept on for the benefit of late comers, even when the ordinary sources have been extinguished for the night.

REVIEWS, ABSTRACTS, AND REPRODUCTIONS.

The Theory of Flame and Incandescent Mantle Luminosity.

By W. H. Fulweiler.

(A paper read at a meeting of the Philadelphia Section of the United States Illuminating Engineering Society, January 15, 1909.)

Luminosity being properly defined as a form of radiant energy that, acting on the human eye, produces the sensation known as light, any theory of luminosity must concern itself with the transformations and properties of radiant energy.

While radiation begins to be apparent as a thermal phenomenon with the aid of a bolometer when it has a wave length of about 19μ (μ is a micron $= \cdot 001$ of a millimetre), and it is believed that the wave lengths may extend even to 30μ in the emanations from the earth, yet our sense of light or colour depends wholly upon the phenomenon of absorption within a very narrow range of wave lengths between about $\cdot 4\mu$ for violet and $\cdot 8\mu$ for deep red. The belief is held by some that in semi-civilized people and in animals this range may be more extended and that they perceive, as light, radiations of greater wave length than are perceptible to civilized people.

Owing also to the peculiar constitution of our eyes, they are not sensitive to all wave lengths to the same degree, and the degree is further modified by the intensity of the light source.

The maximum sensibility seems to lie in the green of the spectrum, so that the first visible radiations, which appear at about 400° C. are of a greyish green.

As the intensity increases the colour spreads slightly in both directions, but principally toward the red end, so that the first clear perception is a dark red, increasing until all wave lengths are represented and the sensation is white, when a continuous spectrum is presented.

Luminous radiations may be excited in several ways: first, and principally, by temperature; second, by chemical or electrical action.

In general, most useful luminosity is excited by solid bodies raised to high temperatures. In the second class come the interesting phenomena known as luminescence, fluorescence, and phosphorescence.

The phenomenon of luminescence is produced by chemical or electrical effects and nearly always in gases. The glowing of a Geissler tube, the oxidation of phosphorus, the green inner cone of a Bunsen burner, are examples of this phenomenon. Solid bodies, however, rarely ever exhibit this action.

Fluorescence is a property of a body whereby it renders visible radiation of too great frequency nominally to excite vision; the action may be compared to that of a step-down transformer.

Phosphorescence is the name given to the property of certain bodies that, normally dark, will for a finite time after exposure continue to emit radiation. The essential exciting radiation is believed to be invisible, so that in this way it is related to fluorescence, but it seems also to partake of the nature of a storage battery.

There is as yet but little definite knowledge of these phenomena in spite of the very considerable amount of research work that has been put on the subject. However, from the recent developments in the phenomena of radio-activity, more definite knowledge may be expected.

Considering now the purely temperature effects as a cause of luminosity, it is well to review briefly the laws connecting radiation and temperature. All of these laws depend upon the principles laid down by Kirchhoff.[1] Briefly they are:—

1. At any given temperature every body sends out the same radiation that it absorbs at that temperature.

2. Black radiation[2 3] must exist in every completely enclosed cavity whose walls are opaque and at the same temperature.

Kirchhoff defines a black body as one which is not transparent and does not

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[1] *Pogg. Ann.*, 109, 1860, p. 109.

[2] *Verhandl. d. Deutschen physik. Gesell.*, 3, 1901, p. 83.

[3] *Wied. Ann.*, 56, 1895, p. 451.

reflect, but that absorbs all incident radiation at every temperature. Its radiation is called "black" or "dark" radiation and at the same temperature is greater than that from every other body both in total energy and in the energy from every particular wave length.

Probably the most general law is that of Stefan and Boltzmann, which was first obtained experimentally by Stefan[1] and later deduced theoretically by Boltzmann.[2] This law states that the sum total of the radiation emitted by a black body varies as the fourth power[3] of the absolute temperature.

$$E \propto T^4.$$

This law is important in showing the rate at which the energy delivered determines the temperature of the body. The Féry radiation pyrometer depends upon this law.

grade degrees the maximum is at a wave length $1{\cdot}8\mu$, while at 2320° it is at $1{\cdot}3\mu$, both of these points being well beyond the visible spectrum.

Wein[1] has brought out a law relating to the point of maximum energy known as the "displacement law."

As the temperature changes, the wave length having the maximum energy in the spectrum will be changed in such a manner that the product of this wave ($\lambda_{max.}$) (in microns) into the corresponding absolute temperature T is equal to a constant A

$$\lambda_{(max.)}T = \text{constant} = A$$

A is found equal to 2960 for a black body and 2630 for platinum.

Wien combined this law with the Stefan-Boltzmann law and deduced the relation

$$J_{max.}T^{-5} = \text{constant} = B.$$

Where $J_{max.}$ is the energy corresponding

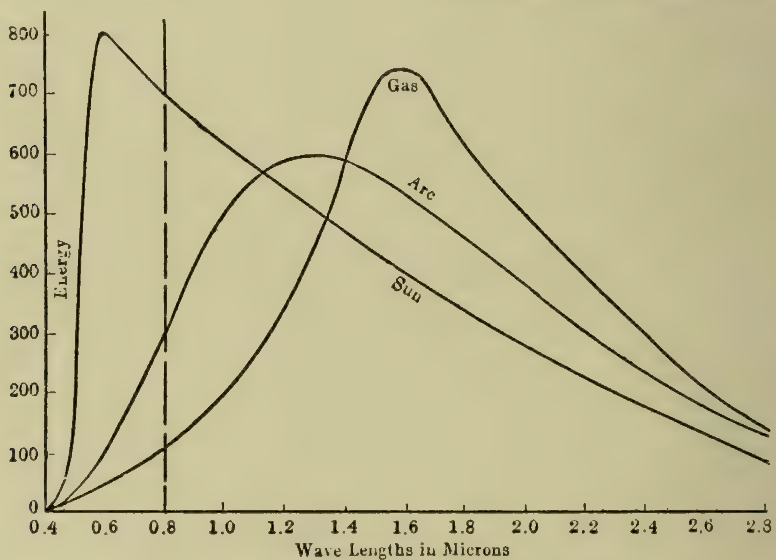


FIG. 1.—Distribution of Energy throughout the Spectrum.

Considering now the distribution of the energy from various illuminants, Fig. 2, it will be noted that even in sunlight a great proportion of the energy lies outside of the visible spectrum, while from the energy curves showing the distribution at various temperatures (Fig. 2), it will be seen that the maximum point moves toward the shorter wave lengths as the temperature increases. For example, at an absolute temperature of 1646 centi-

to the wave length $\lambda_{max.}$ having the maximum energy and T is the absolute temperature.

The constant B is equal to about 14600 while it was found that for other than black bodies the relation should be

$$J_{max.}T^{-a} = \text{constant}.$$

Lummer and Pringsheim[2] found for polished platinum $a = 6{\cdot}00$,

Thus the first law enables one to show that in a black body it would require a temperature of some 5100° abs. or in a body resembling bright platinum some

[1] *Rev. d K. Akad. d. Wiss.*, Wein, 79B, 2-p. 391-428, 1879.

[2] *Wied. Ann. der Physik.*, 22, 1884, p. 31 and p. 291.

[3] Strictly speaking the law is:—
$$E = K(T^4 - T_0^4).$$

[1] *Wied. Ann.*, 46, 1893, p. 633; 52, 1894, p. 132.

[2] *Verh. d. Deutsch. Phys. Gess.*, 1, 1899, p. 218.

4500° abs. to obtain the maximum energy at about ·58μ or in a mean position in the visible spectrum. Of course, these temperatures are as yet unattainable, so that with the present temperatures our systems of illumination must be inefficient.

Lummer and Pringsheim[1] have given some results showing the location of the wave length of maximum energy for various illuminants and the necessary temperature limits that must have been attained.

	$\lambda m.$	$T_{max.}$	T_{min}
Electric arc	·7	4200° abs.	3750° abs.
Nernst lamp	1·2	2450° abs.	2200° abs.
Welsbach mantle	1·2	2450° abs.	2200° abs.
Argand burner ...	1·55	1900° abs.	1700° abs.

The above table shows that even in the electric arc, which represents almost

Now by measuring the intensities of the same wave length at two temperatures the following relation is obtained

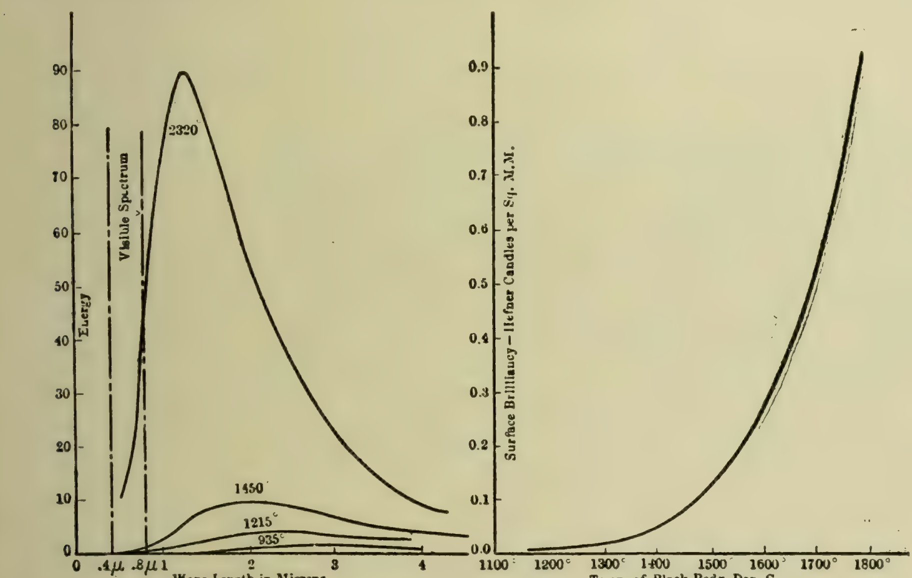
$$ln\frac{E_1}{E_2}=\frac{b}{\lambda}\left(\frac{1}{T_2}-\frac{1}{T_1}\right).$$

Here the constant b equals about 14600.

Coming now to the intensities from solid bodies at high temperatures, there are available the results of the experiments of Lummer and Pringsheim,[1] who measured the variation in the intensity of the radiation emitted from a piece of platinum heated to various temperatures. They found that

$$\left(\frac{I_1}{I_2}\right)=\left(\frac{T_1}{T_2}\right)^x$$

and that valued as follows :—



Figs. 2 and 3.—Energy distribution and surface brilliancy.

the limit of commerical high temperature, the maximum wave length is just in the deep red.

Wien[2] has also developed an expression for the relation between the intensities of any wave length and the temperature :—

$$J=C_1\lambda^{-5}e^{\frac{-C_2}{\lambda T}}.$$

This law evoked a great deal of criticism and was finally modified by Planck[3] in the following form using logarithms

$$ln E=ln\,a-5\,ln\lambda-\frac{b}{\lambda T}.$$

Tem. Absolute	Value of x
1000°	25
1100	21
1200	19
1400	18
1600	15
1900	14

Rusch[2] showed that Tx=constant=about 25,000.

This result shows that at ordinary high temperatures—so-called, such as are used commercially from 1000–1200° C.—the intensity varies about seventeen times as

Verh. d. Deutsch Phys. Ges., 4, 1901, p. 36.
Wied. Ann., 58, 1896, p. 662.
Verh. d. Deutsch Phys. Ges., 2, 1900, p. 202.

Verh. d. Deutsch. Phys. Ges., 11, 1900, p. 89.
[2] *Ann. d. Phys.*, 14, 1894, p. 198.

rapidly as the temperature, and the change in intensity allows a skilled operator with a trained eye to regulate the temperatures quite approximately.

Haber[1] and Rasch[2] have developed from the Wien-Planck formula an expression for the surface brightness of a body in terms of hefner candles per sq. mm. in relation to temperature.

$$ln\mathrm{H}_1 = 12{\cdot}943\left(1 - \frac{2068{\cdot}4}{\mathrm{T}_1}\right).$$

This formula has been checked with the data from Lummer and Pringsheim and Nernst. Fig. 3 shows this relation graphically.

Before leaving the purely theoretical discussion of the subject, it is well to call attention to what is known as selective radiation as selectivity has an important bearing on the whole question.

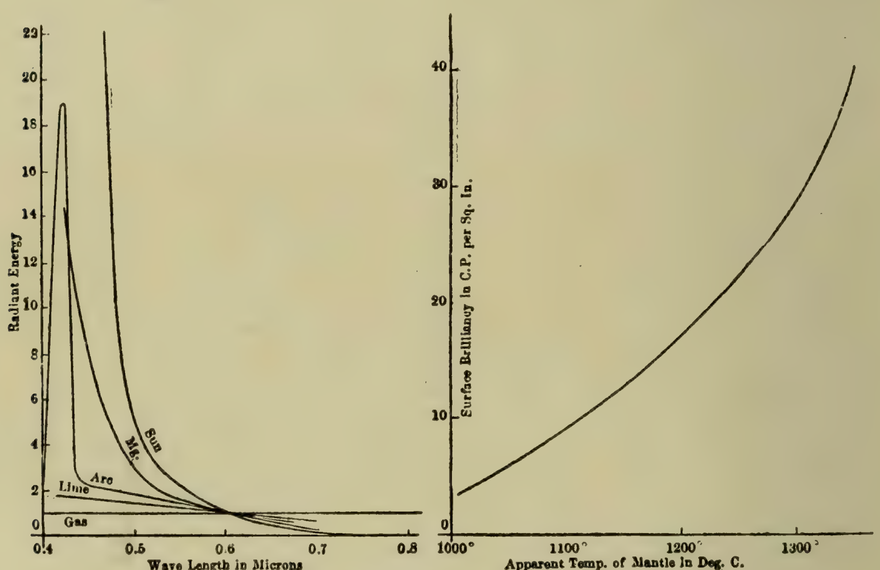
According to Kirchhoff's definition, at any given temperature, both the total energy and the energy of every wave length emitted by a "black" body must be greater than that from any other body.

However, the visible spectrum encloses only a small fraction of the total energy of "black" radiation, a great proportion of which at ordinarily attainable temperatures is in wave lengths too long to excite vision, so that a black body is very inefficient from the view point of luminosity. With any other body at a given temperature, while it radiates less total energy and less energy from any particular wave length than a black body, yet a greater proportion of its energy is emitted in the shorter wave lengths that excite vision. Thus it is seen that the ratio of the visible energy to total energy will be greater than in a black body. Furthermore, the "black body" temperature of any body must be less than its true temperature.

The difference in the ratio of luminous to total radiation with that from a black body is called selective radiation, and may be measured by the difference between the true temperature and the black body temperature for any wave length. All solid bodies show selective radiation and are more efficient luminous radiators than a black body.

Carbon approaches very closely a black body, and is, therefore, less efficient than the metals, such as platinum, tungsten, tantalum, and probably the thoria-ceria mixture, so that if carbon could be raised to the temperature at which tungsten and tanatlum may be regularly worked, it would give more light than they do, but it would be less efficient.

One of the principal causes of the higher efficiency of the metal filament lamps is the fact that they may be worked at very high temperatures; the intensity



Figs. 4 and 5.—Energy distribution and surface brilliancy.

[1] *Thermodynamik technischer Gasreaktionen*, pp. 269, 271.

[2] *Drude Ann.*, 14, 1904.

increases as about the fourteenth power, the energy per second which must be supplied varies only as the fourth or fifth power, of the temperature.

The question of high working temperature is even more important as between carbon and the thoria-ceria mixture in open flames where the exidation of carbon puts even a lower limit on the possible working temperature of carbon in an open flame, while the mantle may be worked up practically to the highest temperature attainable with the flame.

The following table shows the difference between the true temperatures and the black body temperatures for different wave lengths, thereby showing the selective radiation of carbon, platinum, tungsten, and tantalum.

		Black Body Temperature		
	True Temp.	Red ·66μ	Green ·55μ	Blue ·47μ
Platinum	1700° C	1505°	1545°	1575°
Carbon ...	1800° C	1710°	1710°	1710°
Tantalum	1800° C	1700°	1727°	1752°
Tungsten	1800° C	1700°	1724°	1734°

Here we see that the carbon did not vary at all for the three wave lengths used while the platinum varied most widely.

Fig. 4 shows the distribution of the energy in the visible spectrum from various illuminants, using a gas flame as a standard.

The efficiency of magnesium, it will be noted, is extremely high, especially in the shorter wave lengths. Its efficiency has been calculated by Rogers to be about 13·5 per cent.

(*To be continued.*)

A Self-Contained Electric Table Lamp.

A recent number of *The Electrical World* describes a new development in the direction of electric table-lamps. It is pointed out that the ordinary type of lamp lacks the portability of the candlestick, so that where tables have to be moved from time to time so as to vary the dining-room arrangement, the feeding of the lamps with flexible cords in often inconvenient.

Fig. 1.—General appearance of Lamp on Table.

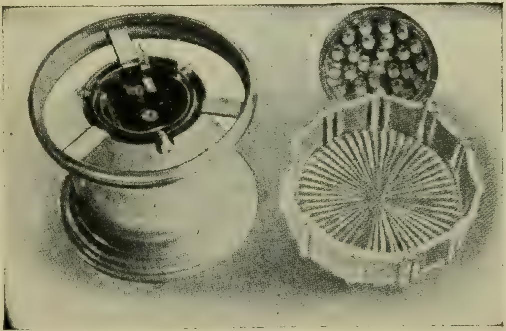


Fig. 2.—Parts of Lamp.

The complete lamp consists of a single storage-cell placed within a silver containing vessel and equipped with three miniature tungsten lamps and a suitable switch for placing them in and out of circuit. The battery stores sufficient energy to keep the lamp aglow for fourteen hours. Fitting neatly over the stand is a shallow dish glass containing cut flowers and water. The flowers are supported by a cast-glass disk with numerous holes into which the stems, &c., project. The lamp thus serves as a flower vase as well as a source of light, the light passing through the glass and water and playing around the flowers and leaves of the contents of the vessel.

Some Automatic Devices for Illuminated Signs.

A RECENT number of the *L'Electricien* contains some description of various automatic devices which are in use on the Continent for the periodical lighting and extinguishing of sign-lamps.

This is very generally accomplished by means of a small motor equipped with a commutating device. A very recent development on these lines has been the scheming out of the successive lighting up of lamps in a diagram in such a way as to give the impression of movement on the same principle as that of the cinematograph. The motions of a crawling snake, for instance, are easily produced in this way and, if the pictures succeed each other with sufficient rapidity, an impression of continuous motion is produced.

On the other hand the use of motors for simple signs, such as would be utilized by a small shop keeper, is not always advantageous, partly because he begrudges the expense and partly because he may not give the motor the necessary attention.

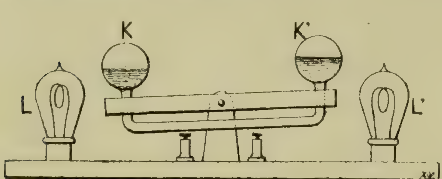


FIG. 1.

A number of simple devices depending upon the action of heat have therefore been constructed recently and an example of such methods is shown in Fig. 1.

In this case two bulbs K and K, partially filled with alcohol, are placed adjacent to two glow lamps in such a way that the liquid in the bulb nearest the lamp is vaporized, thus forcing some of the spirit over into the other bulb, disturbing the equilibrium, and rocking the lever as it does so. This motion of the lever brings the other bulb into closer proximity with the glow lamp and vapourization of the liquid in this bulb now occurs; the lever is thus rocked back into its previous position, and the operation begins anew. The motions of the lever are arranged to make contact with two pins thus alternately lighting up and extinguishing a group of lamps, or, as is preferable, alternately lighting one or other of two banks of lamps, but never breaking the circuit. This last point is of some importance because the continual action of the spark at the contacts in an interrupted circuit would tend to wear them away very rapidly; it is therefore desirable to avoid opening the circuit.

A similar device is illustrated in Fig. 2.

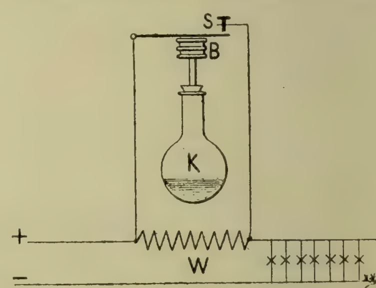


FIG. 2.

When the current passes through the resistance W, the liquid in K is evaporates by its heat, and the vapour inflates the rubber stopper B thus making contacd at S; when this occurs the resistance it short circuited and the lamps in series

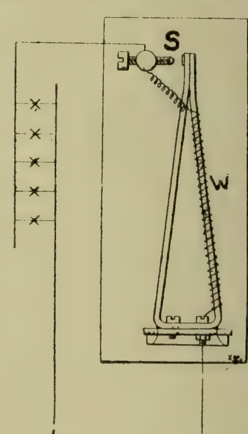


FIG. 3.

brighten up. As soon, however, as the resistance is short circuited, the evolution of heat below K ceases, and cools down, and the operation begins again.

Another form of apparatus dispensing with the use of liquid is shown in Fig. 3.

Initially the current passes through the resistance coil W, and so on through the lamp. By so doing, however, the heat generated causes the bar around which

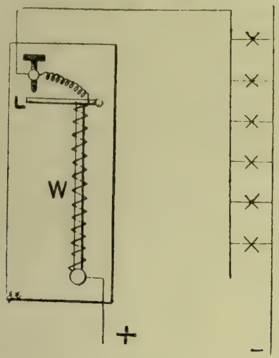


Fig. 4.

it is wound to expand, and this eventually forces a contact at S, which effectually short-circuits the resistance, and stops its heating effect. This causes the arm to go back to its former position putting the resistance W in circuit once more, and the operation begins *de novo*. A somewhat simpler apparatus is shown in Fig. 4.

In this case, however, the expansion of the iron bar, enclosed in a heated solenoid, is magnified by means of a lever, which short circuits the resistance as before.

In discussing the question of contacts the author speaks unfavourably of mercury cups, simple as they doubtless are, and prefers platinum points. He also remarks that it might be expected that such apparatus, depending on the action of heat, would be prejudiced by fluctuations in the external temperature. Naturally, however, such variations are usually too small to affect the apparatus very greatly. On the other hand it is obviously advisable not to place the apparatus in the neighbourhood of groups of lamps, &c., which may exert an influence comparable with that of the heating resistance.

Some Exhibits at the Conversazione of the Royal Society on May 12th, dealing with Interesting Applications of Light.

Mr. C. P. Butler.

Thorp-Butler Concave Replica-Grating Spectroscope.

Some years ago several applications of the Thorp plane replica diffraction gratings were exhibited, notably their use with an opera glass for eclipse work. The only disadvantage of these is the necessity of employing glass lenses for collimator and telescope, which not only increase the expense, but render the instrument somewhat limited, in that the ultra-violet region of the spectrum is more or less absorbed. Recent experiments have shown that concave replica gratings can be made to give very satisfactory results; and by slight modifications of the design of mounting, this form of spectroscope may be employed for any investigation for which the ordinary spectroscope is fitted. A valuable feature appears to be that the radius of curvature may be varied within very wide limits, thus providing instruments of different dispersion and light-grasping power.

Mr. R. A. Robertson.

Photographs for identification purposes of the transverse surface of Timbers;

Reflected light was used and the photographs represent the surface appearance. The magnification is purposely chosen to show only the important details for identification—breadth of annual rings, false rings, distribution of vasa, relative porosity and amount of spring and autumn wood, characters of medullary rays.

Prof. James W. H. Trail, F.R.S.

Preparations to illustrate the Retention of Colours, especially of Green, in Botanical Specimens exposed to light.

The specimens have been treated with acetate of copper, dissolved in acetic acid diluted with an equal volume of water. They are boiled in this solution as soon as possible after they are gathered, the aim being to form a copper-chlorophyll compound and to kill the protoplasm before decay begins. They are then washed thoroughly, and may be dried in the usual methods or mounted in fluids, such as spirit or 4 p.c. formic aldehyde. The examples shown have been selected to show the application of the method to various groups of plants, from algæ to angiosperms. They show that the greens are varied after treatment, due to differences in the natural tints of the parts treated; that only those parts that contain chlorophyll are green in the preparations, and also that certain reds and other colours are frequently retained in these preparations. One or two treated without boiling in the copper solution are shown to illustrate the

difference in results when similarly exposed to light. The method is described in fuller detail in *The Kew Bulletin* (1908, No. 2).

Prof. W. F. Barrett. F.R.S.

1. APPARATUS (*a*) FOR DETERMINING THE LIGHT-THRESHOLD OF THE EYE, AND (*b*) FOR MEASURING THE AMOUNT OF LIGHT IRREGULARLY REFLECTED FROM ROUGH SURFACES.

Two forms of instrument are shown, in both the length of a column of liquid of neutral tint required to produce extinction of the source of light is measured, the scale reading for extinction after one minute's darkness with normal vision being first determined.

2. NEW FORM OF OPTOMETER FOR THE EXAMINATION AND MEASUREMENT OF DEFECTS IN VISION.

Optometers have hitherto been defective owing to the impossibility of preventing involuntary accommodation of the observer's eye. In the present instrument, for which a patent has been granted, this difficulty is overcome by the use of an inclined semi-transparent mirror in the eye-piece. By changing the attachment both pupillometric and entoptic examination of the eye can readily be carried out.

The instruments are made by Messrs. Angus & Co.

Prof. J. Norman Collie, F.R.S.

A CURIOUS PPOPERTY OF NEON.

Perfectly pure neon, when enclosed in a glass tube with mercury and shaken, glows with a bright orange-red colour. As neon does this at ordinary pressures it appears to be different from other gases.

When a silica tube is used and the mercury boiled in it, even at pressures of neon almost as high as atmospheric pressures, the mercury vapour glows bright green.

Dr. A. E. H. Tutton, F.R.S.

CRYSTALS AND COLOUR: THE REVELATION OF CRYSTAL STRUCTURE BY POLARIZED LIGHT.

1. Demonstration of the use of a new form of lantern polariscope to illustrate recent progress in knowledge of the internal structure of crystals. No colour materials whatever will be used to produce the magnificent colours thrown on the screen, all the crystals employed being colourless.

2. A new method of performing the Mitscherlich experiment with gypsum, without any extraneous heating of the crystal,

Mr. C. C. Paterson and Mr. E. H. Rayner.

METALLIC FILAMENT ELECTRIC GLOW LAMP FOR PHOTOMETRIC SUB-STANDARD

This lamp has tungsten filaments in one plane and operates at 1·5 watts per horizontal candle. It is mounted so that it fixes rigidly into a photometer bench carriage and has leads soldered direct to the lamp contacts, thus avoiding uncertain electrical connections.

Mr. J. de Graaff Hunter.

APPARATUS FOR TESTING DEFINITION AND FOR DETERMINING THE VARIATION OF LIGHT INTENSITY IN AN IMAGE DUE TO DIFFRACTION.

The image of an "edge" is formed by the optical system to be examined. This will appear more or less blurred: the object is to measure the light intensity at various points across the very small width of the blurred image. For this purpose the edge is cut on the semi-circumference of a metal disc, the other half of the circumference being cut up into sectors: behind this is a second disc with the whole circumference divided into sectors. These are rotated with a light behind: the light illuminating the edge is reduced by one half, that over the other half of the rotation in a definite proportion depending on the relative positions of the sectors. The image of the edge is viewed by a microscope with a slit in the focal plane parallel to the edge. In general, as the disc rotates there will be a flicker in the light seen through the slit in passing from one semi-circumference to the other; this can be eliminated by moving the slit parallel to itself. This determines the position in the image at whith the light has a certain intensity: other points can be similarly found and an intensity curve drawn.

Mr. S. Cowper Coles.

SPECIMENS OF METALLIC PARABOLIC REFLECTORS, MADE BY ELECTRO-DEPOSITION, AND SPECIMENS OF ELECTRO-DEPOSITED METALS SHOWING THEIR CRYSTALLINE STRUCTURE.

1. Specimens of parabolic glass mirrors coated with gold, copper and palladium.

2. Specimens of glass parabolic mirrors and metallic parabolic mirrors made by electro-deposition, coated with gold and silver bands, so as to give greater penetration in foggy weather and yet retain the dazzling effect required for military purposes,

TRADE NOTES.

[At the request of many of our readers we are extending the space devoted to Trade Notes, and are open to receive for publication particulars of new developments in lamps, fixtures, and all kinds of apparatus connected with illumination.

The contents of these pages, in which is included information supplied by the makers, will, it is hoped, serve as a guide to recent commercial developments, and we welcome the receipt of all *bona fide* information relating thereto.]

The Generation of Electricity from Wind Power.

Attempts have been made from time to time to utilize the force of the wind in this way, the power obtained from the wind-turbine being applied to drive a dynamo. A battery of accumulators is also essential in order to tide over periods of calm, the cells being charged when the wind is available and discharged during the time when there is no wind.

The essential advantage of the method of Childs & Co. is said to lie in a special construction of the wind wheel, which automatically adjusts itself to the wind, and is able to utilize even the faintest breeze. At the same time the turbine also adjusts itself to a strong gale in such a way as not to take more energy than the capacity of the plant demanded. Fig. 1

Fig. 1.—Wind-Turbine (erected at works of Messrs. Childs & Co.).

We have received from Messrs. J. G. Childs & Co., Ltd., of Willesden Green, London, N.W., some particulars of their system of generating electricity from wind power.

represents the wheel erected at the works of the company. This plant is said to be capable of producing about 1,500 units per year under the conditions as regards wind, such as obtain in London

at the height of 50 ft.; by running a tower higher, however, better results could be obtained. Such a plant, excluding battery, will cost about £150.

The apparatus is stated to be completely automatic, an electrical device being added in order to maintain the pressure generated constant, independent of the force of the wind. This is accomplished as follows.

The control of the field circuit is maintained by resistance worked by relay switches, energized by the main circuit. In this particular plant there are six steps. It is obvious that as the velocity of the wind increases the power available on the turbine also increases, and it is possible so to adjust the relay switches that they introduce resistance in or out of the field-circuit as the velocity of the wind increases or decreases. Thus, instead of governing on the speed of the wheel the governing is done on the output of the wheel, and in practice this works satisfactorily, the object being of course to allow the wheel to run at its most economical speed with the range for which it is designed.

Arrangements can also be made to provide for the turbine being thrown out of action when not required. The system is believed to be specially applicable to remote country districts where other sources of power are not available. The actual running cost of the energy generated is presumably nil; some provision must, of course, be made for repairs, though, it is stated, the apparatus shown in Fig. 1, has been running since January of this year without any repairs being necessary. Wind turbines can be designed to suit the meteorological conditions in the district for which they are intended, and can be used for a wide range of work such as country house-lighting, rural factories and agricultural work, and for working lifts, &c., in country railway stations, and so forth. Fig. 2 represents such an installation applied to the working of a lift in a railway station.

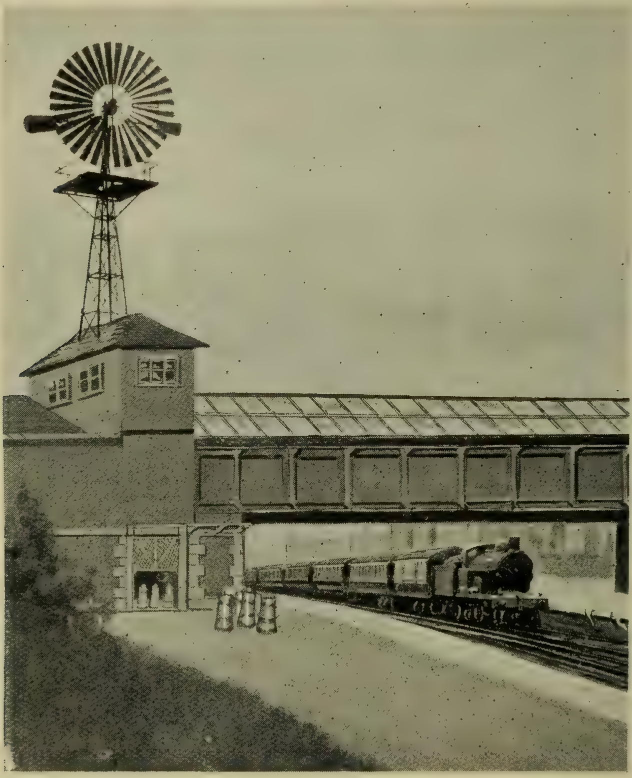


FIG. 2.—Illustrates Application of Wind-Turbine for Generation of Power for Lift, &c., in Country Station.

A New Form of Disc Arc Lamp.

WE have received some particulars of an interesting new type of arc lamp, the essential characteristic of which is that the carbon electrodes are made in the form of discs instead of rods. Ordinary arc lamps, it is pointed out, have frequently to be made inconveniently long, in order to make room for the length of carbon-rod required, and this sometimes precludes their use in warehouses, shops, &c., where space is limited. It is claimed, however, that the disc lamp would not exceed 20 in. over all, and also that the disc carbons are specially convenient as regards packing and storing.

In addition the feeding of the carbon disc is stated to be a relatively simple process compared with the corresponding regulations of rod carbons; the discs are also kept in constant rotation so as to be equally consumed at all points. One advantage is that the disc form of carbon entails a very low resistance.

Carbons of this type are said to be applicable either to flame arcs or to the open and enclosed types. The burning hours of types are stated to be increased to 50 per cent, and that of the enclosed lamp 100 per cent or more. Particulars of this lamp may be obtained from the agents for the patentees, MESSRS BARR & SCOTT, 82 West Nile Street, Glasgow.

Some Gaslighting Fixtures.

AT the third Cantor lecture entitled "Modern Methods of Illumination," delivered before the Royal Society of Arts on March 1st, of this year by the Editor of *The Illuminating Engineer*. A number of modern types of gas-fittings were kindly exhibited by the **Gas, Light, & Coke Co.**, to which, however, it was impossible to refer in detail on that occasion.

More recently we have received particulars from several firms of the representative styles of fixtures exhibited at this lecture, and some of these are reproduced on this and the following page.

Fig 1 represents a type of desk lamp with enamelled iron shade supplied by the **New Inverted Gaslight Co., Ltd.** (Farringdon Avenue, London, E.C.). Such lights are often supplied inverted mantles consuming $2\frac{1}{2}$ cubic feet per hour and credited with a light of 70 candles. Features of special interest in this design are the heavy weight at the base of the lamp giving stability and the adjustable arm at the top enabling the light to be thrown in any desired direction and yet effectively screened from the eyes.

Such fixtures are very suitable for office work, &c., where a special local illumination may be wanted, but the eyes must be protected from the direct rays.

Fig. 1.—Type of Desk Light.

FIG. 2.—Decorative Three-Light Fixture.

A quite distinct type of fixture is that shown in Fig. 2, which represents a decorative three-light fixture supplied by **Messrs. Falk, Stadelmann & Co.** (Farringdon Street, London, E.C.). That there is an immense field for careful study in this class of fixture is now generally admitted, for it is not always easy to turn out an arrangement which is satisfactory from the practical standpoint of giving light where it is needed, and also admirable from the artistic standpoint. It will be observed that this fitting also utilises the now ubiquitous inverted mantle, the application of which, one may anticipate, will considerably modify the previously accepted designs of the decorative class.

Fig. 3 represents a "Metrolite" fixture of **Messrs. Evered & Co., Ltd.,** a feature of which is the use of burners in an inclined or horizontal position, though the *mantle* is maintained vertical. This quality, it is claimed, is often a very serviceable quality in producing certain lighting effects as well as yielding itself to exceptional artistic designs which could not easily otherwise be executed. The mantles used are of the "Bijou" type credited with 30 candle-power at a consumption of $1\frac{1}{4}$ ft. per hour. The method of attaching the globe to these burners is also stated to be very simple.

Lastly, Fig. 4 represents a type of upright floor lamp (**Messrs. Messenger & Co.**), of a serviceable pattern. The general appearance of the fixture, it will be noted, bears a resemblance to an electrical type of standard, though using incandescent gas.

The POLYPHOS ELEKTRICITATS GESELLSCHAFT M.B.H., of Munich, send us particulars of the "Roentgen Universal Induktor."

Cox's Air-Gas System.

A DEMONSTRATION of the advantages of the above system **The Machine Gas Syndicate** (180, Arlington Road, London, N.W.) of petrol-air gas lighting was recently given at the Olympia Building Exhibition; and the editor of *The Illuminating Engineer* was present at the dinner subsequently held on this occasion and made a few remarks on the importance of studying the principles of illuminating engineering in connection with air-gas lighting.

An important point claimed on behalf of this system is the absence of condensation of water or petrol vapour in the pipes. Consequently, it is stated, changes of temperature do not affect the working of the machine, and the system has been largely adopted for the lighting of country houses, &c. One of the largest installations is that at the Royal Artillery Lines, Lydd Camp, Kent. Here about 10,000 ft. of piping are said to have been used, distributing about 2,000 cubic feet of gas per hour, 4,000 ft. of piping being under the ground.

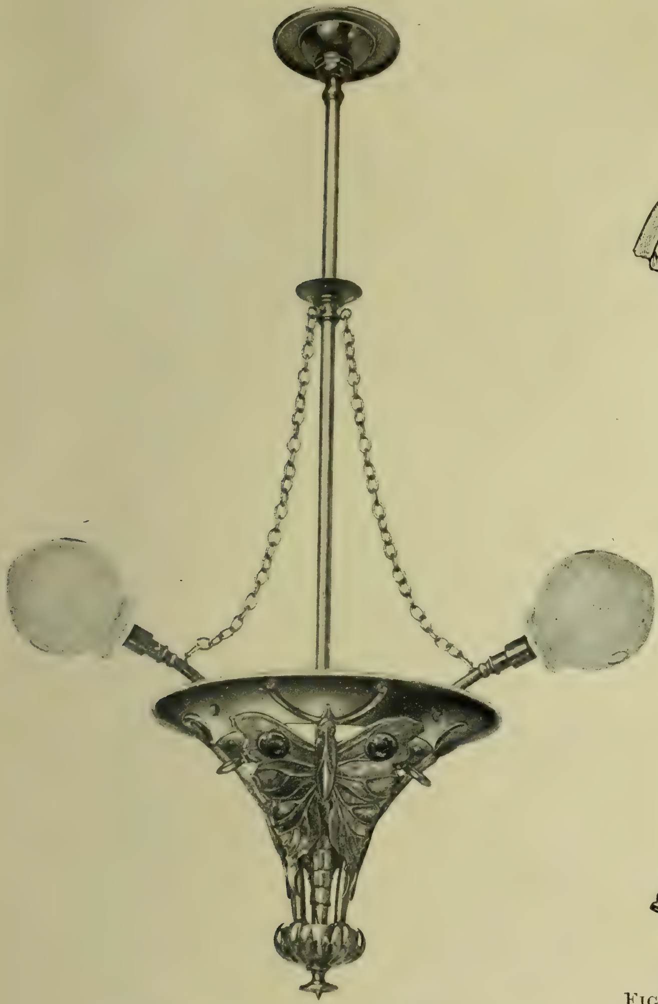


FIG. 3.—Three-Light "Metrolite" Pendant.

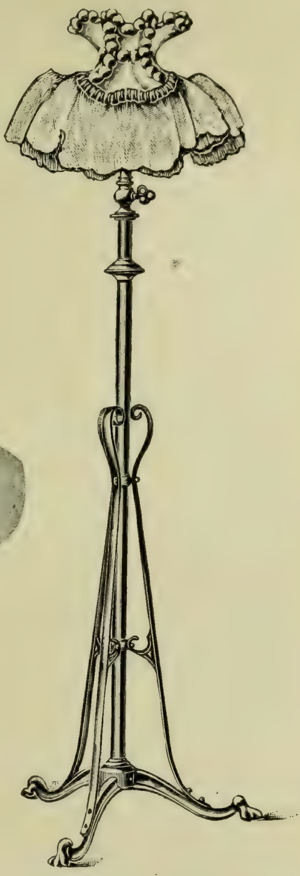


FIG. 4.—Standard Incandescent Gas Fixture.

WE are informed that the **"Z" Electrical Co., Ltd.,** are bringing out a special form of small bulb metallic filament lamp; it is stated that the 25 candle-power 100–110 volt unit will be placed in a bulb not exceeding in size that of the ordinary 32 candle-power carbon filament lamp.

The Schiersteiner Metallwerk Gesellschaft (Berlin) send us particulars of some automatic switches for use in connexion with electric signs, &c. The method involves the use of a small tube containing mercury which is tipped by the expansion of heated wire. By so doing the mercury is caused to flow down to one end of the tube and join two contacts.

The "Roni" Acetylene Burner.

We have received from Messrs. Geo. Bray & Co., Ltd. (Leeds), some particulars of a new form of an acetylene burner, termed the "Roni," an illustration of which accompanies this note. The design of acetylene burners is a matter which requires very careful attention, in order to prevent the possibility of choking with soot, and other troubles. For the "Roni" burner it is claimed that:—

Fig. 1.—The "Roni" Acetylene Burner.

1. The burner is atmospheric, has only one gas orifice, and yet gives a flat flame, having only one orifice, there are no jets of flame to get out of alignment.

2. The gas orifice being larger than the orifices in other acetylene burners of the same size, it is less liable to become stopped up by particles of dust, &c.

3. Having no projecting arms, the "Roni" is much less liable to fracture.

4. It can be used for any kind of acetylene lighting, being equally useful either for domestic or for automobile headlights. It is made in sizes from $\frac{1}{4}$ ft. to $1\frac{1}{2}$ ft.

The "Sparlicht" System of Electric Lighting.

From the *Rheinisch Westfälische Elektro Sparlicht Gesellschaft* (Essen, Germany), we receive a description of the "Sparlicht" system of incandescent lighting utilizing small transformers in connection with low voltage metallic filaments.

A feature of the system is that the transformer is actually built into the holder of the fitting, and is covered with brass, &c., so as to be quite inconspicuous. Ths advantage of using metallic filaments under these conditions are pointed out in this description. It is well known that small voltage metallic filament lamps are often obtainable in small units of 10 or 16 candle-power, and can therefore really effect a considerable saving under favourable conditions; and in addition such lamps having short and stout filaments are less fragile and more durable than those for ordinary supply-pressures.

In this case the transformer is thus invariably switched on and off with the lamp, and, when in use, is always seen at its highest efficiency. The lamps utilized therewith are made with several sizes of holders so that it is impossible to insert a lamp of higher power than that for which the transformer is intended. This last consideration, it is suggested, is a distinct advantage in cases in which the Electric Supply Co. charges the consumer a fixed annual rate per lamp installed, thus doing away with the necessity for meters, and complexities. For the consumer cannot replace the existing lamps in favour of those of higher candle-power without altering his fitting, and the company can feel certain that the nominal wattage will be maintained.

Free Lighting of Shop Windows.

In *The Electrical World* for April 29th, an account is given of a somewhat novel bargain entered into between the Denver Gas & Electric Co., and various shop consumers.

This consists in the free lighting by the company of the window of the shop in return for the setting aside of a small space where the company are at liberty to display their wares, electric irons, lamps, &c.

The Leitner System of Train-Lighting.

We have received a well got-up and attractively illustrated publication devoted to the above system, from which the accompanying illustration is taken. Each carriage is equipped with an automatic electric generating and storing apparatus thus forming an independent centre from which power is supplied to the carriages and also, if need be, to other carriages. The battery of accumulators is capable of supplying the current needed for 3—6 hours.

The exact nature of the electrical apparatus employed is very fully described and is illustrated by abundant illustrations. The volume concludes with a series of reports of various authorities on the sytem. A special claim is put forward on behalf of the value of electric lighting on trains, on account of the ease by which small units of light can be distributed.

At the present time when the subject of train lighting is exciting a considerable amount of attention, both here and in the United States, this volume should be found exceptionally interesting.

View of Electrically-Lighted Dining Car.

Messrs. Marples Leach & Co., Ltd. (Artillery Lane, London, E.C.), send us a descriptive pamphlet dealing with the application of electricity to organ-blowing in churches, &c. The economy and convenience of electric power in this connection is pointed out, and especially the silent working of the apparatus. A feature of the system is the special Marples patent regulator. Where electricity is already installed for lighting and ventilation, the system can be applied and adapted to the existing blowing apparatus; when new organs are being installed arrangements are preferably made with the organ-builders so as to supply the most suitable blowing gear to fit the instrument.

CORRESPONDENCE.

The Efficiency of High Pressure Gas Lighting.

Dear Sir,—I have read with close attention Prof. Strache's article on high pressure gaslighting, and there are several points therein which seem to me to require elucidation.

Prof. Strache refers to the work of Mayer, Schmidt, and others who, it appears, even with the exact theoretically correct proportions of gas and air, did not achieve a higher efficiency than about 37 candles per cubic foot. These and other figures in the paper seem a little difficult to reconcile with the considerably higher values for gaslamps often accepted in this country, notably the 60 to 70 candles per cubic foot which Mr. W. R. Herring has recorded for the Keith lamp. Prof. Morris, it is true, has obtained lower values, which he ascribed partly to a difference in the quality of the gas consumed.

Now that different forms of inverted and other mantles are coming into such general use, it would appear an obvious necessity to avoid any method of testing candle-power which, by selecting the beam of light in any particular direction, is liable to be unfair to one lamp, or too favourable to another.

This point was emphasized by Prof. Lewes in a Cantor lecture on the incandescent mantle delivered before the Royal Society of Arts, as far back as 1900. He said :—

"I have already, on more than one occasion, pointed out the great difference which exists between the measurement of illuminating powers as carried out on the photometer and the illuminating power effect which one obtains from illuminants in practice. The De Lery tassel burner is as good an example of this phenomenon as can be found, for although it gives less light than the oridnary incandescent mantle, when tested at the horizontal in the photometer, its illuminating effect is far superior, and the light, being mostly cast in a downward direction, illuminates the surface below the burner, whilst with the ordinary mantle the bulk of the illumination is thrown from the horizontal upwards, owing to the form of the mantle being a cone."

Even to-day there would seem to be room for confusion in this respect.

What seems to me to be an additional source of difference between the figures quoted in England and Germany is that the former are frequently expressed in terms of the horizontal beam, while in Germany mean hemispherical values are usually quoted. In any case the figures seem to vary more than the admitted difficulty of specifying the exact performance of many gaslamps would justify, and to furnish an example of the need for general agreement as to the means of specifying the candle-power yielded by high candle-power sources, uncertainty in which alone often hopelessly vitiates the customary attempts to compare the relative illuminating efficiency of electrical and gas sources for street lighting.

I am, yours truly,

Athos.

The Eyesight of Wireless Telegraphy Operators.

We observe that Mr. G. Marconi has recently contributed a letter to *The Times*, discussing the point raised by Dr. Bellile in the publication noticed in our April and May numbers.

While conceding the need for protecting the eyes from the radiation of the spark, Mr. Marconi does not seem to fear any ill-effects if simple precautions are taken. His letter was as follows :—

"As I am not ambitious to be associated with any new addition to the already sufficiently sorrowful list of

occupational diseases, perhaps you will kindly allow me the courtesy of your columns to state most emphatically that, whatever may happen in conditions with which I am not acquainted, my own experience, and that of the companies associated with my name, both here and in other parts of the world, supplies no evidence whatever in support of these suggestions. Just as it is necessary to protect the eyes from the effects of any source of intense light, so, in our high-power stations, we find it convenient to surround our sparks and discharges with a non-translucent screen or box; but no other precautions have been found necessary, and the health of our operators and other employés has, I am glad to say, been uniformly satisfactory.

"During the twelve years or so of our operations we have had to deal with no single case of compensation for any injury of this origin, nor, so far as I can ascertain, has any such injury been suffered. Speaking for myself, I may remark that my own good health has never been better than during the often extended periods when I have been exposed for many hours daily to the conditions now challenged, and in the constant neighbourhood of electrical discharges at our Transatlantic stations, which I believe are the most powerful in the world.

"I observe that at least one daily newspaper seems to have pressed the reports to which I have alluded into the service of a further theory that electric waves as used in wireless telegraphy may be harmful not only to the operators, but to the world at large. This suggestion is a very familiar one to me, but hitherto, I confess, it has reached me only through the letters of the insane persons who occasionally beseige me with accusations and threats in respect of the tortures which they imagine me to be continually and of malice aforethought inflicting upon them by the practice of wireless telegraphy."

[We are informed, from another source, that early workers in wireless telegraphy, using a naked spark between metal electrodes, did suffer considerable pain in the eyes as a result, but that this difficulty was subsequently avoided by the use of a suitable sound proof opaque box enclosing the spark.]

Some Publications Recently Received.

[To many of the important publications mentioned in the following list we hope to refer in greater detail on another occasion.]

Elektrische Lichteffekte, nebst einem Anhange; Die elektrische Notbeleuchtung in Theatren und Festräumen. By Prof. W. Biscan. (Carl Scholtze, Leipsic.)—An interesting and well-illustrated volume devoted specially to decorative electric lighting for public streets, theatres, and festive occasions generally; full details are given of a large number of automatic sign devices, &c.

Anlagen zur Versorgung der Gebäude mit Licht und Luft, Wärme und Wasser. Compiled by Drs. F. and H. Fischer, W. Kohlrausch, and E. Schmidt. (Alfred Kröner, Leipsic.)—This volume is the fourth of the "Handbuch der Architektur" series, and deals very completely with the natural and artificial lighting of buldings, ventilation, &c. The volume contains nearly 500 pages, a special feature being the full lists of references to German literature on the subjects dealt with.

Ueber den Wirkungsgrad und die praktische Bedeutung der gebräuchlichsten Lichtquellen. By Prof. W. Wedding. (R. Oldenburg, Berlin and Munich, 1905.).—A reprint from the *Journal für Gasbeleuchtung und Wasserversorgung* of the well-known series of researches of Dr. Wedding dealing with the radiant and practical efficiency of various artificial illuminants.

Die Ziele der Leuchttechnik. By Prof. Otto Lummer. (R. Oldenbourg, Berlin and Munich, 1903.)—The treatise by Prof. Lummer, of Breslau, on the physical theory of light production, and its possible lines of development in the future.

Bericht über die Arbeiten der Lichtmess- Commission des Deutschen Vereins von Gas- und Wasserfachmännern. By Dr. H. Krüss. (R. Oldenbourg, Munich.)—An account of the proceedings of the Commission on photometry and units of light undertaken by the above body of German Gas Engineers in 1897.

Die Erzeugung und Verwendung des Steinkohlgases. By H. Koschmieder. (Dr. Max Janecke, Hannover, Germany.)

Les Produits Industrielles des Goudrons de Houilles et leurs applications. By Vladimir de Vulitch. (Messrs. Gauthier-Villars, Quai des Grands-Augustins, Paris.)

L'Industrie du Goudron de Houille. By Dr. G. F. Jaubert. (Messrs. Gauthier Villars, Quai des Augustins, Paris.)

The Transactions of the Illuminating Engineering Society (United States) for March contain several papers of considerable interest, including that of Mr. E. L. Elliott entitled 'Some Unsettled Problems in Illuminating Engineering.'

The Journal of the Franklin Institute for May contains an article by T. W. Rolph entitled 'The Theory and Practice of Illumination.'

Atti della Associazone Elettrotecnica Italiana for January and February of this year contains some further account of the researches on the behaviour of metallic filaments when subjected to alternating currents undertaken by G. Scarpa.

Société Internationale des Electriciens. Annuaire pour 1909.

The Commercial Engineer's Pocket Book, Electricity Supply. By F. H. Favies. (Messrs. Alabaster, Gatehouse & Co., 4, Ludgate Hill, London, E.C. Price 1*s.* 6*d.*)—This is a handy pocket book intended for publicity department managers, electricity supply and contractors' representatives, and commercial engineers generally. The book is of very moderate dimensions containing only 44 pages of printed matter, but supplies information on a variety of subjects and in a compact and easily accessible form. A special section, embracing 10 pages, is devoted to lighting, and contains a series of figures and practical rules for the determination of the number of lamps required for a given interior, &c. We observe that quotations are given from the statements of authorities on both gas and electricity, and it is satisfactory to observe that the references to the papers from which such figures are drawn are also quoted.

From Messrs. Rentell & Co., the publishers of *Electricity,* we receive a catalogue of works on electricity and allied subjects, which include 'The Art of Illumination,' by Dr. Louis Bell, 'Electric Lamps,' by Maurice Solomon, and other well-known books of interest to the illuminating engineer.

The May copy of *Electrochemical and Metallurgical Industry* contains a variety of articles dealing with different electrochemical processes, &c. In addition a dictionary of chemical and metallurgical terms has been compiled by the publishers, and will contain over 1,000 separate items in this field. We understand that those who now become subscribers to the journal will also receive copies of this dictionary gratis, together with three months free subscription. (Publishers, The McGraw Publishing Co., 239, West 39th Street, New York, U.S.A.)

Among other notices of recently published books we note the following: *Hilfbuch der Elektrotechnik,* by Dr. Karl Strecker, which contains a special section on photometry (Julius Springer, Berlin); *Gasrohrleger und Gaseinrichter,* by F. Kuckuk (Oldenbourg, Berlin and Munich); *Die Versorgung der Städte mit Leuchtgas,* by Moritz Niemann (Alfred Kröner, Leipsic).

We have also to acknowledge the receipt of, among others, the following journals: *Proceedings of the American Academy of Arts and Sciences, American Chemical Journal, American Illuminating Engineering Society, American Institution of Electrical Engineers, Report of the International Electrotechnical Commission, Proceedings of the Institution of Electrical Engineers (London), Transactions of the Iron and Steel Institute, Journal of the Royal Society of Arts, Bulletin of the Société Internationale des Electriciens, Journal of the Röntgen Society, &c.*

Review of the Technical Press.

ILLUMINATION AND PHOTOMETRY.

One of the most important items of news during the past month has been the announcement of the National Physical Laboratory regarding the proposed International Unit of Light. The units in use in France and Great Britain are now in almost exact agreement, but the United States unit hitherto employed has been 1·6 per cent higher than the French and British unit. It is therefore proposed to lower the United States unit into agreement with the other two and to call the common value the International candle. In Germany, on the other hand, it is suggested that a value 0·9 of this international unit shall be employed. There will thus only be two values to deal with and a much needed simplification will have been accomplished.

This announcement has been much commented upon in the gas and electrical press, and has given rise to very general satisfaction.

A considerable amount of discussion has been taking place in the United States regarding the Decision of the Boston Committee, as a result of the visit of their representatives to the Continent and subsequent experiments, to adopt electric lighting in the streets of that city.

Meantime it may be noted that the discussion between **L. Bloch** and **H. Drehschmidt** regarding the respective merits of the Lighting of Berlin by High Pressure Gas and Flame Arcs, still continues. This protracted discussion between these two recognized experts should form a valuable comment on Streetlighting for future reference.

Myles Standish, in Boston, has recently delivered a lecture on the subject of School-lighting. He recommends the use of walls of light yellow-green tints in school-rooms and prefers a subdued general illumination. He states that the Boston Commission have decided against the use of inverted lighting in the schools, although this method has been approved by the Educational Authorities in some parts of Germany. This seems again in conformity with the growing impression that inverted lighting, in conjunction with light side-walls and surroundings, is not the most perfect system of lighting, though it may be serviceable in connexion with additional local lighting. (While touching on this subject mention may be made of an article by A. D. Curtis in *The Illuminating Engineer* of New York for May, dealing with inverted lighting by tungsten lamps). Another lecture commenting on the subject of school-lighting is that recently delivered by G. T. Forrest before the Society of Architects (see *The Builder*, May 19).

An article of some interest from the physiological standpoint is that recently embarked upon but not yet concluded in the *Elektrotechnischer Anzeiger*; the author discusses the types of lamp available for the Production of Light for the Finsen Treatment mentioning the use of high candle-power arc lamps in this connexion. It is interesting to observe that he states the range of radiation that is effective for treatment of this nature to be from $390\mu\mu$ to $490\mu\mu$, *i.e.*, mainly the visible violet. The ultraviolet rays are now believed merely to exert a surface action and not to give rise to the deep-seated physiological effects which the system demands. Another interesting statement is that it is not convenient to use metallic reflectors or glass work for reflecting purposes with such arcs for the generation of ultraviolet light ozonizes the air and the ozone causes the reflecting surface to deteriorate rapidly.

Special attention may be drawn to a recent rather elaborate article in the *Journal für Gasbeleuchtung* by **Klebert** (*J. f. G.*, May 22), which deals with Apparatus for Beacons and flares for use in fogs, &c. A very complete description is given of the various optical systems involved.

Morin (*Rev. des Eclairages*, May 15) makes a few general comments on illumination, and specially points out the distinction between satisfactory Distribution and Diffusion of light. Good distribution of light—evenness of illumination—can most readily be obtained by the multiplication of small sources, but each of these sources may be of concentrated brilliancy and throw sharp shadows: acetylene, it is claimed, is at an advantage here, since the low intrinsic brilliancy of the flame is considered to render shades unnecessary.

Lastly, it will be observed that a number of articles and papers reviewing the GENERAL PRINCIPLES OF ILLUMINATING ENGINEERING DESIGN and the calculation of illumination data. Among these special mention may be made of that by **T. W. Rolph** (*Jour. Franklin Institute*, May), and **A. A. Wohlauer** (*Elec. Rev.*, N.Y., May 6).

ELECTRIC LIGHTING.

Several articles deal with incandescent lamps. That by **Brandt** (*Electrician*, May 21) is an abstract of a contribution which appeared recently in Germany, and has already been referred to in these notes ; it contains the results of a series of tests on tungsten lamps.

O. Vogel (*Z. f. B.*, May 20) discusses the general prospects of development of metallic fiiaments and gives a table of metals which may possibly be utilized in the future.

W. H. Millar (*Elec. World*, N.Y., May 6) gives some experiences of the USE OF HIGH EFFICIENCY LAMPS IN INDUSTRIAL OFFICES. He seems to have obtained very satisfactory results with tantalum lamps, but the mortality among tungsten filaments, owing to the bad effects of vibration, was very excessive. It is suggested, however, that the tungsten lamp may yet be made better able to withstand shock of this nature by the use of some form of cushioning in the holder.

A recent popular article in the *Journal für Gasbeleuchtung* reviews the influence of the metallic lamps on the choice of electrical pressure and tabulates the advantages and disadvantages of high and low voltages to consumer and supply company. It may again be remarked how this journal is adopting the policy of keeping its readers informed on electrical subjects, although dealing mainly with gas.

O. Bussmann (*E. T. Z.*, April 29) contributes a short resume on the properties of the KÜCH QUARTZ TUBE MERCURY VAPOUR LAMP. The article deals mainly with the regulation of the lamp, and explains the part played by the automatic iron ballast-resistance.

GAS, OIL, ACETYLENE, &c.

It will be seen that a considerable amount of matter has appeared during the past month contrasting the COSTS OF GAS AND ELECTRICITY. Chief among such discussions mention may be made of that following the paper by **J. E. King** (*Progressive Age*, May 1), in which a number of instructive points are brought out. Other contributions to the literature of this subject will be found in the British gas journals. For instance, **H. H. Holmes** (*J. G. L.*, May 25) published a rather interesting letter on the subject ; it is pleasant to observe the courteous tone that it is now becoming customary for those indulging in such discussions to adopt. Another standing matter for discussion which has been fully dealt with is the question of the ventilation by gas and electric lighting ; in this both *The Electrical Review* and *The Gas World* take part.

A rather interesting editorial in a recent number of the latter journal advocates the SUPPLY OF ELECTRICITY BY GAS COMPANIES, instancing the case of a company who are applying for powers in this direction ; this, again, is a sign of the times.

Distance gaslighting continues to be the subject of many papers and articles. It seems to be on the programme of several of the annual meetings of gas societies, and a recent contribution by **Wunderlich** is of exceptional interest in this connexion. This writer describes a pyrophoric method involving the mechanical friction of suitable compounds of cerium, which, it is known, give rise to a spark when rubbed. The method, however, has been greatly developed, and, it is said, been tried with some practical success.

A number of papers of considerable scientific interest, though bearing somewhat less directly upon lighting, have also been published. For instance, that by **W. A. Bone** deals with the EFFECT OF SURFACES ON COMBUSTION PROCESSES. Another paper by **J. B. Klumpp** on CALORIMETRY is also of much interest at the present moment.

Special mention may also be made of the list of references to books and publications dealing with gas matters published in the *Journal für Gasbeleuchtung*, (May 8).

A large number of articles dealing with the use of ACETYLENE for various purposes have appeared, many of them readable and bringing forward points of some importance. Some of these describe the application of acetylene to VILLAGE LIGHTING, RIFLE RANGES, AND CINEMATOGRAPHIC APPARATUS, &c.

Buttin (*Rev. des Eclairages*, April 30), also describes the design of a number of ACETYLENE LAMPS INTENDED FOR USE IN MINES in some detail.

One of the most important items of news in connexion with petroleum and oil-lighting is the Congress dealing with this subject being held in London at the time of writing. Various matters connected with the standardization and securing of international uniformity of

methods of testing will be discussed and the decisions of those present are expected to be of considerable importance.

Several articles in the electrical papers in the United States discuss the subject of SIGN-LIGHTING, SPECTACULAR ADVERTISEMENTS, &c. A writer in *l'Electricien* gives some interesting particulars of methods of securing automatic periodic action by the aid of heat instead of the usual motor and commutator. This may be accomplished either by means of the evaporation of a volatile liquid or by the expansion of a metal rod heated by a suitable resistance. It is pointed out that, inasmuch as all such methods involve the use of platinum contact-points, it is advisable to arrange that either of two banks of lamps are switched on (or else either the lamps or an equivalent resistance), so as to avoid the spark following the total opening of the circuit.

An article in *The Electrical Engineer* contains some data regarding the value of ELECTRIC LIGHTS FOR RAILWAY SIGNALS, &c. It is pointed out that such lights have usually to be confined in rather restricted space, so that an oil lamp gradually smokes the face of the lens and reflector, which cannot be frequently cleaned. An electric lamp is, of course, free from this drawback. It is usually found most economical to employ 8 candle-power carbon filament lamps in preference to metallic filament ones; such lam ps have the incidental advantage of being fitted to withstand the constant vibration on a railroad.

A development of some interest, mentioned in several of the electrical papers, is a form of arc lamp, using CARBONS FORMED IN THE SHAPE OF DISCS instead of rods. This, it is claimed, enables a lamp of specified burning hours to be made relatively small in length; in addition the disc-carbons are said to be easy to store and to require only a very simple feeding mechanism.

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Der Einflüss der Metallfadenlampen ouf die Wahl der Gebräuchspannung (*J. f. G.*, May 1).
Spectacular Advertisement Street Signs (*Elec. World*, May 6 & 13).
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GAS, OIL, ACETYLENE LIGHTING, &c.

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Acetylene for Village Rifle Ranges (*Acetylene*, May).
Neuere Anlagen zur Erzeugung von Mischgas aus Leuchtgas, &c. (*Z. f. B.*, April 30).

MISCELLANEOUS.

Lehmann. Ueber einen neuen Projectionschirm mit metallischer Oberfläche für farbige und Lichtschwache Bilder (*Phys. Zeitschr.*, April 15).

CONTRACTIONS USED.

E. T. Z.—*Elektrotechnische Zeitschrift.*
Elek. Anz.—*Elektrotechnischer Anzeiger.*
G. W.—*Gas World.*
Illum. Eng., N.Y.—*Illuminating Engineer of New York.*
J. G. L.—*Journal of Gaslighting.*
J. f. G.—*Journal für Gasbeleuchtung und Wasserversorgung.*
Prog. Age.—*Progressive Age.*
Phys. Rev.—*Physical Review.*
T. I. E. S.—Transactions of the Illuminating Engineering Society.
Z. f. B.—*Zeitschrift für Beleuchtungswesen.*

The Seventh International Congress of Applied Chemistry.

The seventh gathering of the above congress was opened on May 27th at the Imperial Institute, South Kensington, London, when a large and representative gathering of distinguished scientists of different nations was assembled. This is the first occasion on which the Congress has been held in London.

The Prince of Wales, in his opening address, dwelt upon the widening acceptance of scientific method—the replacing of the "Rule of thumb" by the "Rule of Science." This, indeed, very happily describes the aims of illuminating engineering.

We observe that several of the sections of the work of the Congress will bear more or less closely on illumination, and to these we may make further reference in our next number. Meantime we have only to wish the members of the Congress an enjoyable visit to this city and a successful result of the labours of the various sections.

REVIEWS OF BOOKS.

Petrol-Air Gas.

By Henry O'Connar.

Published by Crosby, Lockwood & Son, 1s. 6d. net.

This little book of 72 pages is stated to be written for the non-technical reader, and to be intended as a guide for the benefit of those who are contemplating the installation of a petrol air gas plant on their premises.

The first ten chapters are mainly of a historical nature, dealing in a general manner with the various existing systems of generating means of lighting country houses, and with the development and nature of petrol air gas.

Chaps. iii. and vii. are concerned with the conditions under which petrol can be stored and utilized, and an account is given of the laws dealing with this matter. Chap. iv. deals in a popular manner with burners, mantles &c., and chapters v. and vi. are given up to a description of the principles of petrol air generation and the essential characteristics of a number of well-known plants. A short account is also given of a few types of incandescent lamps of the "Petrolite" class in which a mixture of petrol and air is automatically generated and utilized in the burner.

Within the limits of a book of this class the author can naturally not be expected to deal with every existing type of petrol air installation. We should, however, also like to see mention of several other systems which certainly merit inclusion in a list of the chief modern methods of generating petrol air gas.

PATENT LIST.

COMPLETE SPECIFICATIONS ACCEPTED OR OPEN TO PUBLIC INSPECTION.

I.—ELECTRIC LIGHTING.

5,719/08. Swing out lamp carriers. March 14, 1908. Accepted April 21, 1909. T. L. Scott, 51, Broomfield Avenue, Palmers Green.

9,222. Arc lamps. April 28, 1908. Accepted May 5, 1909. C. A. Carpenter and O. T. Banks, 49, Mortimer Street, London.

9,241. Arc lamps. April 29, 1908. Accepted May 5, 1909. A. D. Jones, Hartham Works, Hartham Road, Holloway.

12,654. Lamps. June 12, 1908. Accepted April 21, 1909. The London Import Co., Ltd., and B. Pordes, 28, New Bridge Street, London.

13,230. Lamp-holders. June 22, 1908. Accepted April 28, 1909. W. Fennell and W. P. Perry, 68, Dudley Road, Tipton, Staffs.

13,449. Incandescent lamps (c.s.). June 24, 1908. Accepted April 28, 1909. P. G. Triquet, 70, Chancery Lane, London.

14,942. Tungsten filaments for incandescent lamps. July 14, 1908. Accepted May 12, 1909. The Westinghouse Metal Filament Lamp Co., Ltd., Westinghouse Building, Norfolk Street, Strand. (From Westinghouse Metallfaden Gluhlampen Fabrik G.m.b.H., Austria.)

15,030. Incandescent lamps. July 15, 1908. Accepted May 12, 1909. F. Wilkins, 6, Lord Street, Liverpool.

15,346. Mounting and feeding carbons in arc lamps. July 20, 1908. Accepted May 12 1909. S. C. Mount and Beck Flame Lamp, Ltd., 27, Chancery Lane, London.

15,979. Lamps. July 28, 1908. Accepted April 28, 1909. Van Raden & Co. Ltd., and M. Metz, High Street Chambers, Coventry.

16,151. Arc lamps. July 30, 1908. Accepted April 28, 1909. The Jandus Arc Lamp and Electric Co., Ltd., and A. D. Jones, Hartham Works, Hartham Road, Holloway.

20,715. Repairing metal filament lamps (c.s.). Oct. 1, 1908. Accepted April 28, 1909. H. Sefton-Jones, 322, High Holborn, London. (From H. Kuzel, Austria.)

21,602. Electric light stand (c.s.). Oct. 12, 1908. Accepted April 28, 1909. J. F. Pierce, Norfolk House, Norfolk Street, Strand.

23,069. Supports for lamp filaments (C.S.). Oct. 29, 1908. Accepted May 12, 1909. The British Thomson-Houston Co., Ltd., 83, Cannon Street, London. (From General Electric Co., U.S.A.) Addition to 16,531/07.

25,443. Filaments for incandescent lamps (C.S.). I.C. Oct. 15, 1908, Germany. Accepted May 5, 1909. H. Kuzel, 322, High Holborn, London.

25,854. Manufacture of lamp filaments from tungsten and like metals (C.S.). I.C. Dec. 11, 1907, Germany. Accepted May 12, 1909. Siemens & Halske Akt.-Ges., Birkbeck Bank Chambers, London.

27,143. Arc lamp (C.S.). Dec. 14, 1908. Accepted May 12, 1909. D. Timar and K. von Dreger, 1, Queen Victoria Street, London.

27,536. Arc lamps (C.S.). D.A. Sept. 1, 1908. Accepted April 21, 1909. A. Holman, 44, West Street, Glasgow.

27,991. Lamp supports and casings. Dec. 23, 1908. Accepted April 28,1909. J. S. Highfield, 322, High Holborn, London.

2,106/09. Lamp holders (C.S.). Jan. 28, 1909. Accepted April 28, 1908. W. Green, 53, Chancery Lane, London.

2,853. Manufacture of lamp filaments from tungsten and like metals (C.S.). I.C. Feb. 11, 1908, Germany. Accepted May 12, 1909. Siemens & Halske Akt.-Ges., Birkbeck Bank Chambers, London. Addition to 4,814/08.

3,951. Manufacture of lamp filaments (C.S.). Feb. 17, 1909. Accepted May 12, 1909. The British Thomson-Houston Co., Ltd., 83, Cannon Street, London. (From General Electric Co., U.S.A.).

8,150. Electrodes for arc lamps (C.S.). I.C. April 14, 1908, Germany. G. Senftner, 18, Southampton Buildings, London.

10,312. Safety lamps (C.S.). I.C. May 2, 1908, Germany. G. O. Walters, 4, South Street, Finsbury, London.

II.—GAS LIGHTING.

10,029/08. Shades or globe-holders for inverted incandescent burners. May 8, 1908. Accepted May 12, 1909. A. E. Smithdale, 88, Chancery Lane, London.

14,835. Inverted incandescent lamps. July 13, 1908. Accepted May 5, 1909. A. E. Podmore and J. Thomas, 256, Croxted Road, Herne Hill, London.

15,644. Incandescent burners. July 23, 1908. Accepted May 12, 1909. W. Sugg & Co., Ltd., and E. S. Wright, 6, Bream's Buildings, Chancery Lane.

18,248. Inverted burners for street lighting (C.S.). Aug. 31, 1908. Accepted May 5, 1909. C. C. Carpenter, 6, Bream's Buildings, Chancery Lane.

23,830. Burner tubes for inverted incandescent pressure lamps (C.S.). Nov. 6, 1908. Accepted May 12, 1909. M. Graetz, 77, Chancery Lane, London.

26,618. Telescopic pendants (C.S.). Dec. 8, 1908. Accepted May 12, 1909. H. W. Hanwell, 111, Hatton Garden, London.

1,581/09. Packing or storing incandescent mantles (C.S.). Jan. 22, 1909. Accepted April 21, 1909. C. J. Sutton and J. Rudd, trading as Pilot Mantle Co., 17, Hanover Street, Keighley.

3,941. Lighting and extinguishing lamps (C.S.). I.C. March 3, 1908, Germany. Accepted May 12, 1909. O. Leopold, 322, High Holborn, London.

4,332. Lighting and extinguishing street lamps (C.S.). I.C. April 15, 1908, Australia. A. J. Bedford, 40, Chancery Lane, London.

III —MISCELLANEOUS.

(including lighting by unspecified means, and inventions of general applicability).

15,089/08. Vapour lamps (C.S.). July 16, 1908. Accepted April 28, 1909. R. D. Cody, 33 Chancery Lane, London.

17,382. Lamps. Aug. 18, 1908. Accepted May 12, 1909. J. T. M. Burgess, Prudential Buildings, Corporation Street, Birmingham.

2,598/09. Lamp shades (C.S.). Feb. 3, 1909. Accepted May 5, 1909. A. Loder, trading as "Adrian," 8, Southampton Buildings, London.

4,690. Vapour lamps (C.S.). D.A. Sept. 19, 1908. Accepted May 5, 1909. W. Fairweather, 65, Chancery Lane, London.

5,473. Illuminating systems (C.S.). I.C. April 27, 1908, Germany. C. Zeiss, 29, Margaret Street, Regent Street, London.

9,879. Shades or reflectors (C.S.). I.C., April 29, 1908, U.S.A. O. A. Mygatt, 56, Ludgate Hill, London.

EXPLANATORY NOTES.

(C.S.) Application accompanied by a Complete Specification.

(I.C.) Date applied for under the International Convention, being the date of application in the country mentioned.

(D.A.) Divided application : date applied for under Rule 13.

Accepted.—Date of advertisement of acceptance.

In the case of inventions communicated from abroad, the name of the communicator is given after that of the applicant.

Printed copies of accepted Specifications may be obtained at the Patent Office, price 8*d*.

Specifications filed under the International Convention may be inspected at the Patent Office at the expiration of twelve months from the date applied for, whether accepted or not, on payment of the prescribed fee of 1*s*.

N.B.—The titles are abbreviated. This list is not exhaustive, but comprises those Patents which appear to be most closely connected with illumination.

The ILLUMINATING ENGINEER

ELECTRICITY · ACETYLENE · OIL · GAS

Edited by LEON GASTER

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EDITORIAL.

The Annual Meeting of the Institution of Gas Engineers.

WE give elsewhere a short summary of the main features of interest to us from the standpoint of illumination in the above meeting. It was generally felt that the meeting was an exceedingly successful one, and that a high standard was maintained both in the original papers read on this occasion and in the reports of work undertaken by the various Committees appointed by the Council. Much of the work referred to is concerned with the technicalities of gas manufacture and does not fall directly within our province. There were a number of points raised in the President's admirable address and in the annual report of the Council which are of very general interest, and worthy of more than casual notice to those concerned with illumination. The comprehensive paper by Mr. Foreshaw, also, to which we hope to refer more fully in our next number, deals with a very important subject. Meantime, we should like to draw special attention to the contribution from M. Sainte-Claire Deville in this number which will be found of great interest to our readers, and elucidates several knotty points in connexion with the author's well-known and much discussed researches.

The remarks of Mr. Thomas Glover, the President, on the value of scientific training to the gas engineer, and the mutual assistance rendered each other by scientific research and practical experience, illustrated very clearly what has been pointed out in these columns before, that the gas engineer of the present day is in a very different position from the man with the more or less rule of thumb methods of a generation ago. It is now realized that there are great possibilities of development in the technicalities of gas-lighting and gas-manufacture, and that men with the necessary scientific training are now needed to take responsible positions in the industry.

Mr. Glover referred in this connexion to the establishment of a Lectureship at Leeds University in memory of Sir George Livesey, and

expressed a hope that the University would serve, not only as an institution for fostering valuable research, but as a common ground of meeting between practice and theory.

We have already referred to the excellent work of the Institution in facilitating agreement on the subject of the proposed international unit of light detailed in our last number. It is, however, satisfactory to find this important achievement duly recognized in the Institution's report. It may, in addition, be pointed out, as Prof. Strache justly observes in a letter published in the current number, that a common basis of understanding regarding the specification of the light yielded by any source of light is also much to be desired. At present there is often no little uncertainty as to whether a given figure is intended to refer to horizontal, mean spherical or mean hemispherical candle-power, and it need not be pointed out that any doubt on this point renders comparison between the performances of different lamps very inconvenient. This, too, is a matter which, it may be hoped, will receive attention shortly, and on which the assistance of representatives of the gas industry will be needed. We also observe that a movement is on foot for placing gas-testing throughout the country upon a common basis, by using a single standard burner throughout; this, it need hardly be said, would be a great simplification, and evidently received the full support of those present.

The Lighting of Factories and Workshops.

This is a matter to which we have frequently made reference in this journal. Yet another opportunity is presented to draw attention thereto by the publication of the Annual Report of His Majesty's Inspector of Factories.

We observe that this report contains a number of references to the defects in the lighting of workshops visited, and comments upon the bad effects to which neglect of this matter gives rise. It is, of course, gratifying to find one of the Inspectors, Miss Patterson, expressing the opinion that the standard of illumination has improved of late years, but the experience of Miss Patterson and other inspectors suggests that there is still room for considerable improvement. Miss Patterson also remarks that, even when artificial illumination is satisfactory, daylight conditions are often very far from being so. This is not altogether surprising, for many people who are aware of the necessity for careful supervision of artificial lighting are apt to assume that daylight must always be fairly satisfactory. As a matter of fact, as Mr. P. J. Waldram has frequently pointed out, and again remarks in the present number, daylight illumination requires the same careful study at the hands of the illuminating engineer as do artificial methods of lighting, and, indeed, presents some peculiar difficulties which are not felt so acutely in the latter case.

The importance of daylight from the hygienic standpoint was vividly brought out by one of the exhibits at the recent demonstration of means of suppressing tuberculosis which has been in progress in Stepney last month. On entering the building one observed two adjacent rooms, one of them so arranged as to prove very satisfactory, and the other an illustration of all that is hygienically bad. The most striking distinction between the two rooms was the contrast in illumination in the two cases. A badly lighted gloomy interior is regarded as furnishing just the conditions favourable to the spread of tuberculosis, and the health-giving qualities of sunlight in this connexion are invariably emphasized by medical authorities.

Several of the inspectors contribute reports which bear out in an interesting manner our conviction as to the close connexion between the standard of illumination and accidents which occur in factories.

But perhaps one of the most interesting contributions to the report in

this respect is that of Miss Squire, who deals with the conditions in textile factories in Yorkshire. Work of this kind necessitates good illumination and it is hardly surprizing to observe that the conditions of eyesight among the workers were often very unsatisfactory. Nevertheless employers, it is stated, often failed to realize not only the humanity, but also the expediency from a commercial standpoint, of providing proper lighting arrangements. In this connexion we may quote the exact words of the inspector. "Sometimes, however, we are met with indifference or reluctance to spend money on these conditions for healthy work, *and we have no statutory provision to rely upon.*"

We have often drawn attention to this very point and this authoritative endorsement of our conviction as to the need for legislation comes as an encouragement to further efforts. The contents of this report prove that Dr. Legge, H.M. Medical Inspector of Factories, and his assistants are alive to the great importance of the question with which we are concerned and we feel confident that steady efforts to bring the matter home to the public will not be wasted.

The Proposed International Unit of Light.

On page 443 in the present number will be found an account of the paper read by Mr. C. C. Paterson, before the Physical Society, dealing with the above subject. The discussion to which the paper gave rise might create an impression in the minds of some of those reading the remarks of the various speakers, that the question of the suggested international candle, was bound up with the question of the merits of various types of standards.

We wish to point out that, for the present, this is not really the question at issue. It is, of course, fully admitted that there exists at the present time no authenticated standard which is not open to objection from some standpoint, and different nations and experts may be expected to show a leaning to the type to which they are most accustomed. But this does not affect the value of the important practical agreement on the subject of a common unit. At present it may be understood that any laboratory or any nation is entitled to preserve their unit by the use of standards which they find most convenient. Most photometric experts, for example, admit that in actual working, it is usually convenient to compare gaslamps against a gas-standard and electric incandescent lamps against an electric standard. Both types have their own sphere of utility, and it is futile to argue as if either were worthy of universal condemnation.

The good work done by the International Electrotechnical Commission must be recognized, in this connexion and we wish them every success.

Illuminating Engineering Ideals and the Truth.

At the Seventh International Congress of Applied Chemistry, which was opened by the Prince of Wales at the Albert Hall on May 27th, a speech was delivered by Dr. Harvey Wiley, the Chief of the Bureau of Chemistry in the United States, which may be regarded as summarizing, in an admirable manner, the attitude of the chemist towards scientific researches. In the course of his remarks Dr. Wiley stated that the chemist was, above all, an agent for enlisting the truth, as every true man of science must be.

We think, however, that this description is peculiarly apt when applied to the Ideal Expert Illuminating Engineer, whose mission it is, to a peculiar degree, to weigh and balance the different views put forward, in order that truth may prevail. For the whole truth is not easily to be learnt; it is many sided, and we can only hope to form a just conception of the merits of a question by giving due weight to the views of all those who are interested in its different aspects. In Hygiene, for instance, the chemist does valuable work, but much of this would be

limited in scope were it not for the co-operation of the Medical and other Professions. Much effective sanitary legislation of the present day is the result of the combined effort of the chemist and the physiologist, a combination of analytical processes with hygienic principles—for example, the analysis of food for purity, and the detection of adulterations, the analysis of water, air, the detection of crime from poisoning, &c. It is only by the aid of facts, clearly established by accurate testing, that legislation can be framed to protect the public. In the same way we hope, in the future, to see Governmental Recommendations introduced dealing with hygienic principles of illumination, but before this can be done we must first be in a position to collect facts and data, such as will guide us in framing a course of action which would be the outcome of consideration given to all these distinct but important aspects of the matter. Concerted action, as we have often explained, is the very keynote of the Illuminating Engineering Society, and constitutes the only possible means for establishing the truth.

The Design of Headlights for Vehicles.

Of late years the growing complexity of traffic conditions, and perhaps even more the increasing speed at which modern vehicles travel, has made it clear that the existing methods of arranging headlights are not all that could be desired.

It is, in fact, a matter which requires some forethought to arrange headlights so that they fulfil the double purpose of lighting up the way for the driver's benefit and warning pedestrians and others of his approach. Recognizing the need for scientific study of this question, the Royal Automobile Club are organizing a series of tests of headlights for motor cars, &c., which will take place at the Crystal Palace on July 19th, 1909. We publish elsewhere the essential details of the scheme according to which these tests are to be conducted, and it will be seen that the question of candle-power of the sources of light employed, and the distribution of light in the beam from the lens in the most effective manner, are to be the subject of special attention. First among the points of merit we note the *absence of dazzling effect.* This matter was recently the subject of comment by Mr. M. O'Gorman, to whose remarks we also refer. Stress is laid upon the desirability of arranging the main beam of light so as to illuminate the roadway without allowing the projection of rays above the eye level, which the club assume to be 4 ft. 6 in. above the ground.

Some additional data might, we think, well be ascertained regarding the intrinsic brilliancy of the sources studied, and the distribution of light in the beam. It is reasonable to suppose that information as to the integral light from a source—the candle-power—from the point of view of its tendency to cause dazzling, is chiefly of value when considered in conjunction with the concentration and intrinsic brightness, *i.e.*, the intensity per unit area. It is recognized, for instance, that the "glare" effect of a naked metallic filament would certainly be more severe than that of a paraffin lamp of the same candle-power, and one might suppose that similar considerations play some part in motor car headlights.

There can be no doubt, however, that the work which the club is undertaking is of a very serviceable nature, and we feel sure that the competition they are organizing will elicit a number of useful facts. Their action in this matter is one more excellent illustration of the progress in the scientific study of illumination at the present day. LEON GASTER.

Review of Contents of this Issue.

Mr. A. P. Trotter (p. 439), in the present instalment of his article discusses the possibility of ANGLE-ERRORS WITH THE RITCHIE WEDGE. He describes some experiments undertaken on this point which suggest that such errors cannot be calculated from theoretical considerations of incident illumination alone, and are actually less than some previously published investigations of this nature would suggest. Mr. Trotter also describes the action of the SLOT or LIMIT-GAUGE photometer, and the GRID-PHOTOMETER in which the differential action of a series of slots, arranged on the perforated screen principle, is utilized.

On p. 443 will be found a summary of the conditions leading up to the recent announcement regarding the PROPOSED INTERNATIONAL UNIT OF LIGHT, as set forth by Mr. C. C. Paterson in a recent paper before the Physical Society, and the discussion thereof. The discussion turned mainly upon the merits of different types of standards of light, DR. J. A. FLEMING referring to the Violle standard as theoretically preferable to a flame, while DR. C. V. DRYSDALE preferred the use of a specified black surface maintained at a certain prescribed and definite temperature. This is followed by the official communication from the Bureau of Standards, Washington, U.S.A., relating to the corresponding announcement issued by that institution and giving an account of the considerations on which the proposed unit is founded.

On p. 448 will be found an important announcement from the Illuminating Engineering Society regarding Application for Membership.

An article by **M. Sainte Claire Deville** (p. 451) contains a summary of his conclusions regarding the connexion between the CALORIFIC VALUE AND INCANDESCENT ILLUMINATING POWER OF A GAS. He shows how the conclusions formulated are necessarily governed by the definition of incandescent illuminating power adopted, and the assumptions on which such experiments are carried out. When this is borne in mind the apparent lack of agreement of some of the author's experiments with those recorded by other investigators can, he seeks to demonstrate, be quite simply explained.

Following this contribution will be found an account of the proceedings at the ANNUAL MEETING of the INSTITUTION OF GAS ENGINEERS. Some account is given of the Presidential Address by Mr. Thomas Glover and of the paper by Mr. C. Foreshaw comparing the incandescent illuminating efficiencies of hydrogen and carbon monoxide.

On p. 457 will be found the first instalment of an article entitled HIGH DUTY GAS LIGHTING. by **Mr. Thomas Holgate.** In the section included in the present number the author reviews, in a general manner, the relative merits of flame arcs and high-pressure gas lamps, dwelling specially upon the difference in the nature of the distribution of light in the two cases. This he substantiates by reference to a previous article by Prof. J. T. Morris in this journal. He also deals briefly with the effect of different qualities of gas upon the efficiency obtainable from high pressure lamps, illustrating his remarks by a table summarizing the results by Prof. J. T. Morris, Mr. W. R. Herring, and Prof. W. Wedding.

Dr. M. Gaster (p. 462) continues his article on THE WORSHIP OF LIGHT. In the present section the author extends his remarks to many different religions and nations in different parts of the world pointing out how, in many instances, religious and legendary beliefs are all traceable to the original worship of light and the light-giving heavenly bodies.

An article on p. 466 deals with FACTORY LIGHTING, with special reference to the annual report just issued by H. M. Chief Inspector of Factories. The evidence of many of the inspectors

is quoted, with the object of showing how the importance of paying attention to the daylight and artificial lighting of factories is now becoming realized. In many cases, it is stated, even when artificial means of lighting were considered fairly satisfactory, the daylight conditions left much to be desired. Special attention may be directed to the evidence of one inspector to the effect that the absence of any statutory provisions on the subject of illumination is often felt to be an obstacle in inducing employers to provide proper facilities.

Mr. P. J. Waldram in an article entitled A STANDARD OF DAYLIGHT ILLUMINATION IN INTERIORS (p. 469), urges the desirability of adopting some systematic method of studying the qualities of an interior as regards access of daylight. A connexion, it is suggested, may be established between the actual illumination in such an interior and the unrestricted illumination outside. Mr. Waldram gives the value of the factor connecting these two quantities for a number of different types of buildings which he has been studying, and gives a few instances in which some method of predetermining the qualities of an interior from the point of view of illumination, might be very serviceable.

Among other articles in this number attention may be drawn to that dealing with TESTS OF MOTOR HEADLIGHTS (p. 476). The design of lights on vehicles is felt to be a matter for special care in view of the rapidly moving traffic which now fills the streets. The Royal Automobile Club are therefore organizing a series of tests with the object of deciding upon types of lights which effectively illuminate the roadway without exerting a dazzling effect on the eyes of pedestrians and drivers on whom the beams from the powerful headlight fall.

The article by **Mr. K. Sartori** is completed in this number (p. 479). The author, in the present section, gives the results of a test upon the MERCURY CARBON GLOW-LAMP, and makes a few remarks on the photometry of glow-lamps in general.

Following this article will be found some particulars sent us by a correspondent regarding the method of STREET LIGHTING to be adopted in BOSTON, U.S.A. Magnetite arc lamps, it is stated, will be employed in series and will consume practically the same current as the enclosed lamps replaced ; the gradual substitution can thus proceed without interference with existing arrangements. The system adopted in this case is of special interest in view of the scientific experiments upon which the decision of the authorities in this city were founded.

Among other articles in this number attention may be called to that dealing with the ILLUMINATION OF A BOWLING ALLEY, a somewhat specialized, but instructive problem in illumination (p. 449). Attention may also be drawn to the summary of some rules regarding the SPACING OF OUTLETS in interiors drawn up by the Holophane Company (p. 483), and to the up-to-date summary of the PRESENT PRICES OF METALLIC FILAMENT GLOW-LAMPS, &c., on p. 486.

In the Correspondence columns of this number will be found some selection of communications of varied interest. **Mr. J. S. Dow** replies to the letter on the subject of VISUAL ACUITY AND COLOUR recently contributed by Prof. L. Weber. **Prof. H. Strache** comments upon the loose METHODS OF EXPRESSING THE INTENSITY OF HIGH POWER GAS LAMPS sometimes adopted in different countries ; in giving such figures, he says, it should be clearly stated whether the intensity in any particular direction, mean spherical, or mean hemispherical intensity is intended. **Dr. P. Bellile** deals with the remarks of Mr. G. Marconi on the effect of ULTRA-VIOLET LIGHT AND EYESIGHT OF WIRELESS TELEGRAPHY OPERATORS, explaining that a distinction must be drawn between the conditions prevailing on land and on a man of war.

At the end of the volume will be found the usual **Review of the Technical Press** (p. 499) and the **Patent List** (p. 503).

TECHNICAL SECTION.

[*The Editor, while not soliciting contributions, is willing to consider the publication of original articles submitted to him, or letters intended for inclusion in the correspondence columns of 'The Illuminating Engineer.'*

The Editor does not necessarily identify himself with the opinions expressed by his contributors.]

Illumination, Its Distribution and Measurement.

By A. P. Trotter,

Electrical Adviser to the Board of Trade.

(*Continued from p.* 370.)

Angle Errors of the Ritchie Wedge.—Some writers with a child-like and touching faith in Lambert's cosine law, which is true enough, and indeed almost self-evident so far as incident illumination is concerned, and forgetful that as Bouguer found, it does not apply to light reflected diffusely from a screen, have based various assertions about "angle errors" from figures found in a table of cosines, to which they fondly cling without trying experiments. Some statements on 'Causes of Error in Photometry,' which appeared in vol. lvii. of *The Electrician*, are in more sense than one of a wild character. It is stated (p. 529) that with a Ritchie wedge of 120° (as in Fig. 57) "a deflection of the carriage of 1° will increase the illumination of one surface by 3 per cent, and reduce that of the other by 3 per cent, making a total error of 6 per cent. There are very few photometers in use in which the carriage cannot be deflected through this small angle of 1°, so the errors involved are perhaps more often greater than less than 6 per cent." The writer goes on to say, "supposing that one of the lights is displaced horizontally and at right angles to the photometric axis by ½ in., the distance from light to screen being, say, 30 in. This will cause the light rays to impinge upon the screen at an angle of 59 or 61 deg. instead of 60 deg., and this will produce an error of 3 per cent in the measurement of candle-power.... With a photometer screen so arranged that the rays shall fall perpendicularly upon the surfaces to be viewed, the error due to want of alignment is quite negligible, a displacement of one light by ½ in. in 30 in., producing an error of only 0·02 per cent, this being the difference between the cosine of 0° and cosine 1°."*

These statements are true enough of incident illumination, but not of the brightness of screens, and are therefore not true of "measurement of candle-power."

The following experiment was made with a perforated screen photometer, but the results would have been the same with a Conroy or Ritchie wedge made of the same material.

Fig. 78 gives the results of tests of two different pairs of screens with two different pairs of lamps nearly 16 candle-power each, and 100 inches apart. The difference is due to a slight difference in the nature of the surface of the cardboard. The want of symmetry of the curves is due to slight difference between the surface of the pair of screens. A very slight glaze disturbs the curve greatly at an angle of 10° for the incidence is then 45° on one screen.

* See also correspondence in the same volume of *The Electrician* on this subject.

The photometer head was turned "against the sun" through 15°, its axis therefore pointed over my left shoulder. This is called +15 on the diagram. Ten readings were taken. The head was then turned through 5° successively until it pointed —15° to my right. The means of the sets of ten readings for each angle were as follows :—(See Curve A)

Angles.	—15	—10	—5	0	+5	+10	+15
Readings.	96	103	105	107	109	112	118

Between +5° and —5° the difference for 10° is 4 per cent by actual experiment, and it may be safely deduced that for 1° the "angle error" is about 0.4 per cent instead of 6 per cent. Examination of Fig. 78 will show that

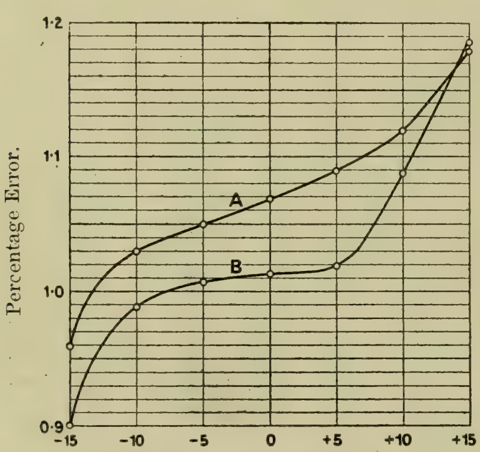


FIG. 78. Angle Errors.

the existence of this angle error depends upon the want of bilateral symmetry of the curve for dulled Bristol board about the ordinate 35.

Another pair of screens viewed not square with the bar, but square with the photometer head gave the following means of sets of ten readings. (See Curve B.)

Angles.	+15	+10	+5	0	—5	—10	—15
Readings.	1186	1089	1018	1013	1008	9886	9004

The angle error for a difference of 10° between +5° and —5° is one per cent. Another test gave +5°=1095, —5°=1030, or 0.65 per cent for 1°.

I have not tried displacing one of the lamps, but it would probably produce half the error.

L. Weber invented this photometer independently and described it at the meeting of the National Science Association at Schleswig-Holstein in April, 1893.* He called it the Dach photometer from the resemblance of the cards to a roof. The name Roof photometer has the merit of brevity, but it is hardly descriptive enough. Anything is better than using the name of one of the inventors, especially in these days of technological colleges and examinations.

After alluding to the "clever scheme worked out by Messrs. Lummer & Brodhun," and "their highly ingenious arrangement of prisms," Herr Weber writes, "Every theoretical requirement is fulfilled in the principle of my little Dach photometer, in that the spot (in this case the opening) has absolute transparency, and the surrounding cardboard is opaque, while each surface examined is illuminated from the one light-source. For these reasons the Dach photometer gives the simplest solution of every theoretical demand."†

The Slot or Limit-gauge Photometer.—A modification of the foregoing pattern consists in the use of three slots instead of a simple hole. This kind of screen is specially adapted for use with a photometer head fixed relatively to the working lamp. The slotted screen receives the light from the working lamp and the plain screen at the back receives the light from the lamp under test. The working lamp is on the right. The right hand side of the front screen being a little nearer the light is more brilliantly illuminated, and the left a little less. Similarly, the left hand side of the back screen is a little brighter than the right.

FIG. 79.

When a balance is obtained, the middle slot disappears, the slot on the right appears dark, and the one on the left appears bright. It is easy

* *The Ill. Eng.* of New York, Vol. I., p. 901.

† *Zeitschrift für Beleuchtswesen*, October 30th, 1906; *The Illuminating Engineer* of New York, Vol. I., p. 901.

to arrange the slots as a limit gauge for any particular candle-powers.

Let W (Fig. 79) be the working lamp of 10 candle-power fixed at one metre from the centre of the photometer head P, that is, from the centre of the middle slot of the screen. Let L be a lamp under test. If it is a 16 candle-power lamp it will be 1,265 mm. from P. But let a lamp of 14·4 candle-power, that is one 10 per cent less in candle-power, be placed at L. There will no longer be a balance at P. The point of balance will be shifted away from W. The point of balance may be found by the formula on page 224, and would be 0·4545 of the distance W L from W. But W L is 2265 mm., therefore the point of balance will be 1029·4 mm. from W, or 29·4 mm. to the right of the centre of the middle slot. Cut another slot, the centre of which is at this point, and the 14·4

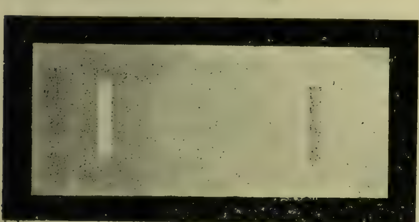


FIG. 80. Slot Photometer, with Central Slot in Balance.

candle-power lamp, though fixed at L, will balance here. In the same way it may be found that a left hand slot, the centre of which is 26·5 mm. from the centre of the middle one will balance a lamp 10 per cent. brighter, that is 17·6 candle-power. The projected view of these slots as seen in the photometer, when the middle one is in balance, and therefore practically invisible, will be as in Fig. 80, but an illustration cannot show the subtle differences of tone with accuracy. The arrangement of the slots in plan are shown in Fig. 81 to half scale. The displacement of the horizontal axes is considerable, and the working lamp should be moved about 90 mm. towards the observer. This displacement and the distances between the slots would be reduced by the use of a working lamp of less candle-power, placed at a less distance than one metre.

A photometer arranged thus acts as an engineers' limit, or "go and not go" gauge. Lamps can be quickly sorted into three sets, those within the limits, those above, and those below, without any motion of the photometer or any reading of the scale.

The same principle may be used for facilitating ordinary measurements, without a definite relation between the slots. If the lamps to be measured are of about the same candle-power as the working lamp, the distance between the slots can be determined from the scale. Take the working lamp as 10 candle-power. The division 10 is one metre

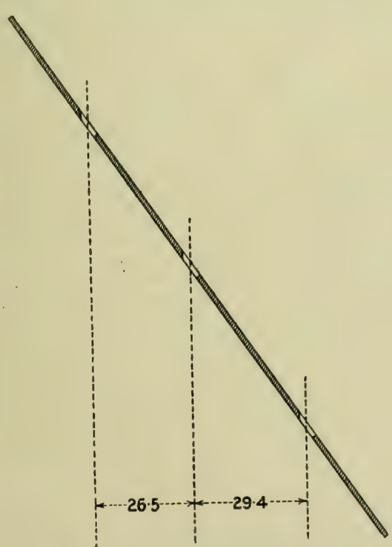


FIG. 81. Slot Photometer, Plan.

from the photometer head, 10·3 is 1014·9 mm. from the head, or 14·9 mm. to the left, and 9·7 is 984·9 from the head or 15·1 mm. to the right. Cut a slot on each side of the centre one, with centres at these distances. Aim for a balance with the middle one, and the two side slots being about 3 per cent high, and 3 per cent low will help in getting a balance, and will give an indication of the precision with which the adjustment is being made. These distances are the apparent or projected distances. For a screen set at 35°, the actual distances are 1·74 greater

(the reciprocal of cos 35°); but it is easier and quite accurate enough to set them out graphically as in Fig. 81.

When seen in the photometer the slots will lie at the right distances for 3 per cent difference on such a scale with the two 10 candle-power lamps, and a somewhat altered difference when one of the lamps is greater or less than 10 candle-power.

The Grid Photometer.—The photometers which have been described are suitable for measuring the candle-power of a steady light. If the candle-power frequently alters, only occasional measurements can be made when a balance can be caught. In 1894 when I was endeavouring, at the suggestions of Prof. S. P. Thompson and Mr. J. Swinburne, to obtain a standard of light from an arc lamp,* I found that the light was continually varying, and I devised a form of photometer by which the fluctuations could be followed, and the instantaneous value could be determined at any time. Such a photometer is not likely to be required except for such researches, but it may be described here as it is of the Ritchie or Conroy type.

At this time I had not recognized that 45° is a bad angle for a Ritchie screen, and I used that angle, and had to take considerable care to avoid specular reflection. The photometer consisted of a long narrow screen set at 45° to one light, and in front of this, inclined at 45° to the other light, and making 90° with the former, there was a screen consisting of a large number of narrow bars forming a grid, Fig. 82. The screens are enclosed in a box, and are observed from the direction O. The lights fall on the screens through two openings from the directions A and B. The lamps are arranged opposite the middle of each opening. The screens were about 12 in. (305 mm. long, the lamps were displaced about $4\frac{1}{2}$ in. (114 mm.) from the centre line. Sighting points or a parallax mirror are needed for keeping the direction O at right angles to the bar. The grid should be observed from a distance

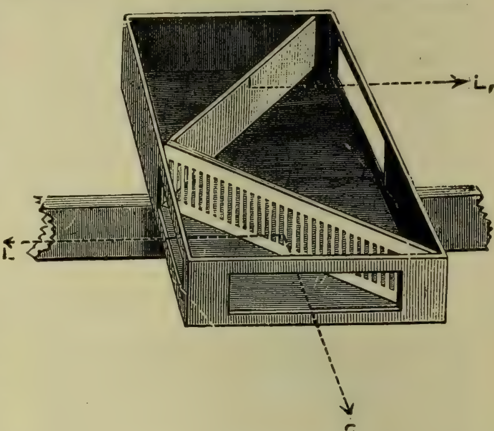


Fig. 82. Grid Photometer.

of six or eight feet. When two steady lights are used, the bars on the left of the grid are brighter than the back screen, and the bars on the right are less bright. A band of uniform tone is seen between the two. When the whole box is moved this band remains stationary. When one of the lamps varies, the band may be seen moving backwards and forwards. Its position may be read with reference to the scale on the bar below.*

* *The Ill. Eng.*, Vol. I., p. 93, 94, and *Journal* Inst. Elec. Engineers, Vol. XXI., p. 360.

* For further details see *Phil. Mag.*, July, 1893.

(*To be continued.*)

The Absorption of Various Globes.

(W. E. Barrows, 'Electrical Illuminating Engineering').

		per cent.			per cent.
Clear glass	globes absorb from	5–12	Ground glass	globes absorb from	20–30
Light sand blast	,, ,, ,,	10–20	Medium opalescent	,, ,, ,,	25–40
Alabaster	,, ,, ,,	10–20	Heavy	,, ,, ,,	30–60
Canary coloured	,, ,, ,,	15–20	Flame glass	,, ,, ,,	30–60
Light blue alabaster	,, ,, ,,	15–25	Signal green	,, ,, ,,	80–90
Heavy blue alabaster	,, ,, ,,	15–30	Ruby glass	,, ,, ,,	85–90
Ribbed glass	,, ,, ,,	15–30	Cobalt blue	,, ,, ,,	90–95
Opaline glass	,, ,, ,,	15–40			

The Proposed International Unit of Candle-Power.

By C. C. Paterson.

(Abstract of Paper read before the Physical Society on June 11th.)

A paper summarizing the steps that have led to the establishment of the proposed international candle was read before the Physical Society by Mr. C. C. Paterson on June 11th, and gave rise to an interesting discussion.

In tracing the development of the movement Mr. Paterson mentioned that the possibility of international agreement between France and England was referred to by Dr. Glazebrook in 1908.*

The chief factor in the present movement, however, had been the desire of the authorities in the United States to establish one unit for both gas and electrical industries in that country, and the possibility of their adopting a unit which should be identical with those existing in Great Britain and France led them to take the initiative in an attempt to obtain international co-operation. The agreement which had resulted had the approval of the Metropolitan Gas Referees and now formed the subject of an authoritative announcement. (The text of this announcement, included in Mr. Paterson's paper, was published in our last number).

Mr. Paterson then proceeded to mention the various standards of light in use in different countries.

In the initial adoption of a unit of candle-power the United States of America endeavoured to make its value as nearly as possible the same as that accepted at the time in this country. This was before Prof. Vernon Harcourt and the Metropolitan Gas Referees (London) had established the 10 candle-power Pentane Lamp on the present definite basis.

The American Inst. of Electrical Engineers recommended the derivation of their unit from the Hefner Lamp by increasing its value in the ratio of 0·88 to 1. This seemed at the time to be the most probable ratio between the Hefner and British units. The gas industry in America, however, did not follow this course but developed their unit along the lines of the 10 candle Pentane Lamp.* As a result there had been, up to now, an appreciable difference between the units adopted in the two industries in that country. The Illuminating Engineering Society and other bodies took the matter up energetically, and the Bureau of Standards, Washington, now had the support of the leading institutions in America, in defining the value of a common standard, to be accepted throughout the States. This Institution had ascertained by means of electric intercomparisons the ratio of their present unit to those of Germany, France, and Great Britain respectively, and had arranged to adjust the value of their unit as already indicated.

When flame lamps were burning in a closed room it was well known that their candle-power diminished, due probably to the vitiation of the air in the immediate neighbourhood of the flame.† Two standards did not diminish in candle-power at the same rate, and it was therefore necessary to take readings after the air of the room had been changed and before the candle-power of the lamps had had time to be affected. The method of measuring humidity must therefore be a rapid one, and it was now generally agreed that from considerations of accuracy and quickness of reading the

* See *The Illuminating Engineer*, Oct., 1908, p. 831.

* 'The Working Standards of Light and their Use in the Photometry of Gas,' Ch. O. Bond, Franklin Inst., 1908.

† Report Amer. Gas. Inst., "Methods of taking C.P. of Gas," *Illum. Eng.*, 1909, p. 203.

ventilated hygrometer was the best instrument to use.*

Mr. Paterson then proceeded to comment upon the limiting accuracy which, he thought, *under the most favourable* conditions enabled measurements to be taken with an error of + or — 0·1 per cent. In this connexion he pointed out the value of standard glow lamps which had been interchanged for comparison between the various laboratories prosecuting these researches with good effect. Subsequently he presented a table of comparisons of the units undertaken at different dates, by different laboratories, and explained the basis of the announcement of the National Physical Laboratory, published in our last number. According to this announcement, it will be recalled, the proposed new international unit will have the values :—

1 Pentane Candle.
1 Bougie Decimale.
1 American Candle.
1·11 Hefner Unit.
0·104 Carcel Unit.

Therefore 1 Hefner Unit=0·90 of the proposed unit.

The discussion was opened by Prof. J. A. Fleming, who explained the defects of flame standards of being so much affected by the atmospheric conditions in the room in which they were used. He referred to his experiments on the Pentane lamps as far back as 1902,† and quoted figures from a paper by Mr. J. S. Dow to illustrate this point. He felt very strongly that the ultimate standard of light ought not to be a flame, but a flat surface of some incandescent solid material, which could be electrically heated if need be, and free from atmospheric influences. It was in order to avoid the necessity of using flame sub-standards that he was led to devise his large bulb glowlamps.

He inquired whether any attempt had been made at the National Physical Laboratory to repeat Mr. Petavel's promising work on the Violle standard in this direction, and regretted that the Laboratory has resolved to adhere to a flame standard.

Mr. Alexander Russel complimented the National Physical Laboratory and Mr. Paterson on the useful work in which they had assisted in promoting the international unit. He thought, however, that the question of the ideal primary standard lay rather outside the scope of Mr. Paterson's paper. With reference to the Violle standard Mr. Russel mentioned that some recent work was not in conformity with the older results.

Dr. Drysdale thought that Mr. Paterson was to be congratulated on his summary, and the international agreement arrived at was most welcome. As he understood the paper, however, it was simply an attempt to obtain agreement between present existing units rather than standards, and left the matter of the best form of standard perfectly open. He thought that every one having experience with flame standards would thoroughly agree with Prof. Fleming's condemnation of them, and there could be no doubt that the primary standard should be an incandescence one. He, however, did not agree with Dr. Fleming's suggestion of reviving the Violle standard. What was wanted in an incandescence standard was a definite area of a definite surface at a definite temperature. When the Violle standard was suggested we had little knowledge of the radiating properties of surfaces, or of high temperature measurement, and therefore the only suitable thing was to take a very pure substance using its melting point as a bench mark of definite though unknown temperature. But every one who had studied the history of the Violle standard was aware of the great difficulties of setting it up, and it had the disadvantage, according to Petavel, that the surface was dependent on the gas mixture used besides an extremely short period of constancy and high expense. In the meantime we had realized that a perfectly black body was easily obtainable, and that it had perfectly definite radiating properties; we had the laws of Stefan and Wien,

* Proc. Roy. Soc. Edinburgh, vol. 43, 1905; also 'Zur Kenntniss des Ventilierten Psychrometers,' Akademische Abhandlung der Fakultat der Universitat zu Upsala, by Aron Svensson, 1898.

† *Jour. Inst. of Elec. Eng.*, vol. 32, p. 144.

and optical pyrometry had advanced to a high degree of accuracy, and it therefore seemed decidedly preferable to suggest a unit area of a black body at a definite temperature. Mr. Jolley and he had come to the conclusion that a square centimetre of a black body at a temperature of 2,000° absolute would perhaps be a good unit and would be probably of the order of 100 candle power. This temperature was probably pretty close to that of the ordinary carbon filament glow-lamp, so that there should be no colour difficulty, and it should not be exceptionally difficult to maintain constant. If the temperature were measured by an optical pyrometer of say the Féry form based on the Stefan law, the deflection would be proportional to the fourth power of the absolute temperature, while the light according to Lummer and to integration from Wien's law was proportional to T^{12}. Hence the light would be proportional to the cube of the deflection only, and the error probably would not be large. Finally a point in favour of the black body was the perfectly definite character of its spectrum which made it a standard of colour as well as intensity and suitable for spectrophotometric comparison. As the surface would be that of a solid it would be unnecessary to maintain it in a horizontal position, as with the Violle standard, and the amount of light could be easily varied by a diaphragm. He believed that Dr. Guilleaume and other French Physicists, advocated the black body standard.

Mr. J. S. Dow remarked that the discussion had turned on the subject of standards rather than units. He wished, however, to make it clear that he did not condemn the Pentane standard as Dr. Fleming's quotation might perhaps suggest. Considered as a flame standard, he thought it ranked high, and gave very constant results when used in a scientific manner. Certainly flame standards had very serious drawbacks. But one must be cautious as yet in basing an incandescent standard upon results on a black body or other radiation which might need revision. For instance, Féry had shown that some surfaces hitherto regarded as black exercised marked selective action; this seemed to suggest that the results of Lummer and others might need revision.

Whatever standard we adopted, the decision regarding the international unit was a very welcome one, and great credit was due to the Illuminating Engineering Society in the United States for taking the initiative. The co-operation between gas and electric authorities in both countries had rendered international action feasible, and proved that those connected with both illuminants could work together for the common good. The present step forward might appear to some to be but a small one, but it formed an important precedent. The ultimate goal was a single international unit, and it might be hoped that Germany would soon fall into line, for, as Mr. Gaster had recently pointed out, it was to her advantage, as a large exporter of glow-lamps, to adopt the same unit as that of other countries. Meantime the adoption of the simple ratio of 0·9 was a step in the right direction.

Dr. Drysdale said that he thought Mr. Dow had slightly misunderstood the nature of Prof. Féry's results, and it would be unfortunate if this should militate against the idea of the black body as a standard. There was no difficulty in obtaining a perfectly black body either by an enclosure or reflector. What Prof. Féry's recent experiments had shown was not that Kurlbaum's black radiators were at fault, but that he had been in error in assuming the perfect absorption of platinum black with which his receiving bolometer was coated. This had necessitated an increase of the constant in the Stefan formula from Kurlbaum's value of 5·32 to 6·32, but this was a point which could easily be settled, and did not indicate any real difficulty in the use of the black body or the determination of its temperature, which could be simply exterpolated from known temperatures by the aid of the Stefan law.

In reply Mr. Paterson explained that his paper was concerned with the practical question of an international unit, rather than the choice of a

primary standard. He was afraid that if the National Physical Laboratory had concentrated their efforts on the Violle standard instead of working with the Pentane *pro. tem.*, practical agreement on a unit would still have been unrealized. Every one, of course, was aware of the influence of atmospheric conditions on all flame standards. Still, if the Pentane lamp were used under laboratory conditions *as* a standard, it was possible to repeat results to one-tenth per cent if due precautions were taken and the proper connexion made ; of course, such a standard was not intended for rough industrial work. In addition, the Pentane standard had the considerable merit of being the only legal standard of light in this country, namely, the official standard of the Gas Referees.

Speaking of the Violle standard Mr. Paterson remarked that the red colour of the light from melting platinum, under the prescribed conditions, was a disadvantage. It was even ruddier in tint than the Hefner. On the other hand, it might be admitted that the adoption of the temperature of melting platinum seemed very definite. He was not quite sure whether high temperature conditions could yet be preserved with sufficient exactitude in the case of a black body, as Dr. Drysdale had suggested.

He might make special mention of the new incandescent standards using tungsten filaments, which were now employed at the National Physical Laboratory. At present it seemed as though these would yield very constant results indeed, and the colour of the light approached that of the Pentane flame very closely.

The International Unit of Light.

We have also received from the Bureau of Standards, Washington, U.S.A., an official announcement regarding the proposed international unit, which is similar in substance to that of the National Physical Laboratory reproduced in our last number (*The Illuminating Engineer*, June, 1909, p.393).

The following remarks are also appended to the official notice issued by the Bureau of Standards. They are of considerable interest in explaining the situation, and will be read with interest in connexion with the discussion of Mr. Paterson's above paper :—

The above announcement marks an important step forward in the history of photometric measurements. For many years the British parliamentary candle was the unit recognized in this country, but the lack of precision in practical photometry did not permit its value to be very accurately expressed or reproduced. In recent years the gas industry has employed the 1 candle-power sperm candle, the 10 candle-power Harcourt pentane lamp, the Hefner lamp, and various secondary standards, while the electrical industry has employed incandescent electric lamps either certified by the Bureau of Standards or rated in terms of standards that are consistent with those of the Bureau. The unit of the Bureau has been maintained very constant, as shown by frequent comparisons with the standards of France, Germany, and Great Britain, but differed appreciably from the British unit and hence from the unit employed by most of the gas companies in America.

The Bureau of Standards took the initiative several years ago in bringing about international uniformity in the unit of light by sending its representatives abroad with copies of its standards to determine more accurately the relative values of the units of the several European countries and to urge the adoption of an international unit. In this country the American Institute of Electrical Engineers, the American Gas Institute, and the Illuminating Engineering Society have acted together in support of the movement, and have voted in advance to recognize the new unit of candle-power.

In England the National Physical Laboratory has secured the endorsement of the London Gas Referees and the Institution of Gas Engineers.

The union of the three national standardizing institutions of America, France, and Great Britain in maintaining a common unit of candle-power, and the co-operation of the German Reichsan-

stalt in redetermining, from time to time, the ratio of the Hefner unit to the common international candle, assures the highest attainable constancy for the new unit of light.

Unfortunately there is no primary photometric standard that is sufficiently constant and reproducible to be generally accepted as an international standard. France, Germany, and Great Britain, each has its own primary flame standard, and a great deal of effort has been expended in attempting to determine accurately the relations between them. Until the flame standards themselves are better understood, however, and the atmospheric and other conditions more perfectly controlled, the unit of light can not be preserved as accurately by primary flame standards as by incandescent electric secondary standards, The latter, when well made, properly seasoned, and carefully measured, permit comparisons to be made (using the means of many settings on several lamps) with excellent precision, the lamps themselves being constant enough and the precision of measurement high enough to fix the final values to about one or two tenths of 1 per cent. There is good reason to believe that in this way the international unit of light can be preserved so nearly constant that any inevitable drift occurring one way or the other would be too small to detect with certainty by any of our present flame standards in many years. The Bureau of Standards will continue to standardize flame standards by the electric standards and will also carefully investigate the more important flame standards. Similar tests and investigations will also be made in Europe, and if any appreciable drift does occur it will sooner or later be detected.

Careful distinction should be made in this connexion between a *unit* and a *standard*. An international unit maintained by the co-operative effort of several national standardizing institutions, and checked from time to time by means of all the best primary standards in use, is more likely to be maintained constant than if it were defined to be represented by any single primary standard, unless such a primary standard were reproducible to a very high degree of precision. Such a *unit* can be continued permanent even though all present primary *standards* are ultimately superseded by better ones. The Hefner lamp as a convenient flame *standard* will not be displaced in America or any other country which adopts the international candle as its unit of light. Uniformity among different countries and continuity of value are prime necessities with respect to the *unit*. But the particular standard by which the unit is realized in practice is largely a matter of convenience and circumstance. In the photometry of electric lamps, electric standards are most suitable. In gas photometry one form of flame standard or another will be employed according to circumstances. It is not expected that all countries of the world will at once adopt the proposed international candle as their unit of light. Those countries which already have the Hefner unit in general use may prefer to continue it. But if all countries which have a unit differing appreciably from the Hefner shall adopt the international candle as their unit, there will then be only two units in use throughout the world, and they will have the simple ration of 9 : 10. This would result in a distinct gain both in the practice of photometry and in definitions and nomenclature.

The effect of this change of 1·6 per cent in the unit of the Bureau, which is in general use for electric lighting throughout the country, is to raise the candle-power rating and decrease slightly the watts-per-candle of electric lamps. A 16 candle-power lamp will give 16·26 candles in the new unit, or a 16 candle-power carbon-filament lamp burning at 110 volts will give 16 candles on the new basis at 109·69 volts. The change, though small, is important in the photometry and rating of lamps.

The new unit of candle-power being in agreement with the present English unit as represented by a 10 candle-power standard pentane lamp, there will be no change in the unit of light now employed by those gas companies which use pentane lamps, provided they are in agreement with the English standard. But as pentane lamps may differ slightly from one another, even when burned under the same conditions, it is desirable for the sake of greater uniformity to have them standardized in terms of the standard candle of the Bureau. These variations, amounting to from 1 to 5 per cent, are generally in the same direction; that is, the lamps if not correct usually give less than 10 international candles under standard conditions when burning in a pure atmosphere at a normal barometric pressure of 76 c.m. of mercury and an atmospheric humidity of 8 litres of water vapour per cubic metre. In anticipation of this change some of the largest gas companies in the United States have already had their pentane and Hefner standard lamps standardized by the Bureau in terms of the new unit.

Gas standards will hereafter be certified in terms of the international candle. Electric standards will be certified in terms of the old unit until July 1st, 1909, unless otherwise requested. On July 1st the new unit will be adopted by the Bureau of Standards in the certification of electric standards, and it is hoped that manufacturers of electric lamps will adopt the new unit as soon thereafter as possible.

The Bureau recommends that all gas and electric companies, all photometric laboratories, and all the manufacturers of electric lamps in the United States adopt the new unit of candle-power, if possible, not later than January 1st, 1910.

Further information with regard to change of photometric unit or to the testing of gas and electric standards will be given on request.

S. W. Stratton,
(Director, The Bureau of Standards, Washington, U.S.A.)

Proceedings at the Annual Meeting of the British Acetylene Association.

In our last number a short reference was made to the annual meeting of the British Acetylene Association, at which the Presidential address was delivered by Mr. C. Hoddle (*Illuminating Engineer*, June, 1909, p. 394). Owing to pressure of space we are obliged to hold over the detailed account of the proceedings, together with several letters we have received commenting upon Mr. Hoddle's address, which, however, we contemplate publishing in our next number.

The Illuminating Engineering Society

(FOUNDED IN LONDON, 1909).

IMPORTANT NOTICE.

RE APPLICATION FOR MEMBERSHIP.

At the Council meeting held on June 18th it was decided that the subscription paid by those who join the Society during the present year should cover the period up to December 31st, 1910; members so joining will receive their Journal from the time of their becoming members up to the above date.

All intending members are requested kindly to fill in and return their forms on application for membership to the Hon. Secretary at their earliest convenience.

Previous to the opening session next November, anyone who is desirous of joining the Society may be nominated by any of those present at the Inaugural Dinner on February 9th of this year (whose names have been published in **THE ILLUMINATING ENGINEER,** March, 1909, p. 160), who constitute original members; or, in the event of his not being known to any of these gentlemen, by members of good standing in other societies, as provided in the Constitution of the Society. An intending member may also fill in and return his application to the Hon. Secretary, leaving his nomination to the decision of the Council, as directed at the meeting of May 25th.

Forms of application may be obtained from the HON. SECRETARY, 32, VICTORIA STREET, LONDON, S.W.

The Illumination of a Bowling Alley.

A VERY special case of lighting—the illumination of bowling alleys—was the subject of discussion in a recent number of *The Illuminating Engineer* of New York. Although of a somewhat specialized nature, this problem illustrates nevertheless some of the main principles of good illumination very clearly.

It might, of course, as Mr. Macbeth the author of the article, declares, be rendered almost impossible either to see the pins clearly or to follow the course of the balls aimed at them, if the lighting was accomplished by sources of a dazzling nature placed in the direct line of vision. The sources distributed along the alley must therefore be high up out of the line of sight and well-screened. They must also enable the light to be concentrated downwards, so that the balls can be clearly followed all along the course, and distinguished from one another. An additional advantage of placing the sources high is that the inconvenience of marked horizontal shadows from the travelling balls is avoided.

A good general illumination is necessary. Moreover, as the distance of the balls from the bowler increases, it becomes proportionally hard to distinguish them and trace their course. Therefore a special gradually increased illumination along the alley, culminating in a maximum at the pins, is required in addition. This gradual piling up of the illumination towards the centre of interest—the pins aimed at—naturally serves to concentrate the interest on the ball as it rolls. In the particular case shown in the illustration an illumination gradually mounting from 0·67, at the point from which the ball is

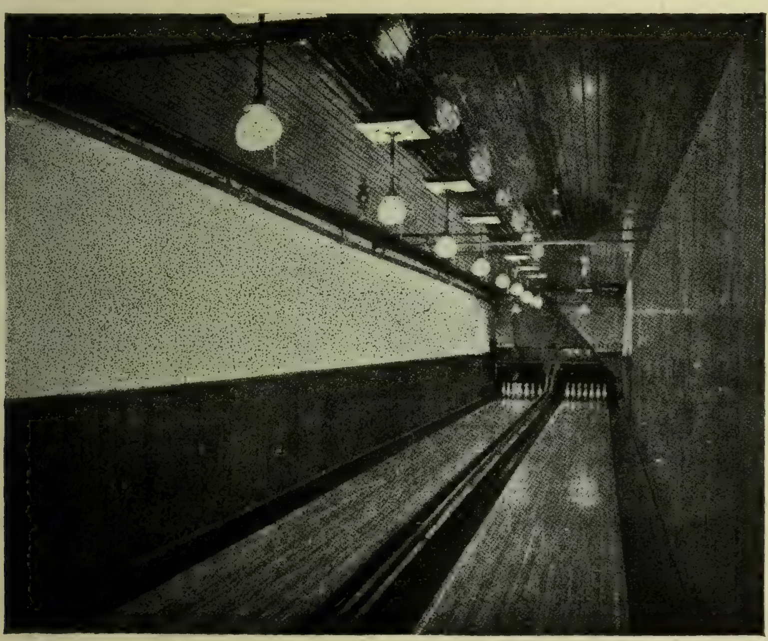


FIG. 1.—Illumination of a Bowling Alley.

delivered, to 5·45 foot-candles, at the pins, was employed.

The general nature of the scheme of illumination will be gathered from the accompanying figure. Inverted incandescent mantles are employed down the alley, provided in each case with a green white-lined shade. Special local illumination of the pins was provided, and also, at the spectators' end, special local illumination of the score-board. The alley is just about 60 ft. long.

The Lighting of Schools.

THIS important subject was referred to in some detail by Mr. G. Topham Forrest, M.S.A., architect to the Northumberland Educational Committee, in a recent paper entitled 'Secondary Schools: their Planning and Equipment,' read before the Society of Architects on May 13th, and reproduced in a recent number of *The Builder.*

In this connexion the lecturer's remarks, as follows, form an interesting illustration of the recognition of the necessity for proper methods of lighting, and their consideration as a distinct and important item in the scheming of an educational building :—

In secondary schools situated in large towns liable to fog, and where work is carried on in the afternoon and evening, the question of artificial lighting becomes one of great importance. Now that the medical inspection of school children has become compulsory it behoves the school architect to see that the doctor shall have no good reason for tracing cases of visual fatigue to defects in the lighting of the school premises.

Up till quite recently it is surprising how relatively small an amount of consideration has been given to the problem of artificial illumination in schools. The general question as to whether gas or electricity is the more suitable illuminant for a school is a large one, but the lecturer prefers incandescent gas.

The even distribution of light is the underlying principle which governs the correct application of artificial illumination. This is essentially so in schemes of interior lighting, To attain this end, endeavour should be made to follow as far as possible the distribution and characteristics of daylight illumination, namely, downward and oblique direction, steadiness of the light, and broad diffusion in order to avoid sharp and deep shadows —not, however, seeking to eliminate shadows entirely, as these by forming contrasts are helpful and materially assist the eye in its judgment of the form of objects.

In all forms of artificial illumination, the intrinsic luminosity or the intensity of the brightness of the luminous surface should be kept as low as possible, or in other words the surface from which the light emanates should be as large as possible because—(1) The strain on the eye will be as small as possible; (2) the shadows will not be deep, and the difference between light and shade will be reasonable.

Eminent lighting authorities lay down the rule that the maximum allowable luminosity should be below five candles per square inch of illuminating surface. Obviously this means that some method of diffusing the light, either by means of shades or globes, should be adopted wherever the radiant is directly in the field of vision, so that the diffusing surface may be within the limits of a comfortable working intensity.

The amount of gas consumed by an inverted burner should be always carefully adjusted, so as to get the best results, and if the pressure of gas in the street mains is a varying one, either a volumetric governor of the size necessary to pass the requisite amount of gas should be fitted on each burner, or a pressure governor should be fixed on the meter. In some districts the pressure in the street mains varies as much as 50 per cent, so that without some governing arrangement it is manifestly impossible for the burner to give its best and most economic results.

Observations on the Relation existing between the Heat of Combustion of a Gas and its Incandescent Illuminating Power.

By M. Sainte Claire Deville
(Member of the International Photometrical Commission).

In order to explain—or rather to render plausible — the approximate practical proportionality which exists between the calorific power of a gas and its incandescent illuminating power, it is not necessary to invoke any very elaborate scientific principles.

It suffices to bear in mind the following two points : (1) By the incandescent illuminating power of a gas we understand the maximum value of the luminous efficiency, expressed in terms of the light yielded for a given gas-consumption. Now it has been demonstrated experimentally that a burner adjusted so as to yield this efficiency is very far from furnishing the absolute *maximum of intensity* possible.

If the consumption of gas and air is increased, the actual light yielded by a mantle may also become very much greater, but this increase proceeds at a lower rate than that in the gas consumed, so that the efficiency falls off in value.

The temperature of the mantle cannot in any case exceed that of the flame, and, consequently, in the case of maximum efficiency is considerably lower. This being admitted I imagine that a complete analogy may be drawn between the behaviour of an incandescent burner and that of a platinum disc on which a stream of heated air is allowed to impinge. The temperature of such a disc of platinum will depend mainly on two factors—the temperature of the blast of air and its speed of projection.

It is evident that a jet of air at a temperature of 2,000 degrees, which is sufficiently slow will heat the disc to a lower temperature than one at 500 degrees travelling at a very rapid rate. It is clear, too, that the disc will not assume the temperature of the stream of air unless the latter attains a certain very high speed ; an increase in speed from this point onwards would produce no effect. In no case, however, will the temperature of the disc exceed that of the stream of air.

But, inasmuch as the disc is usually at a lower temperature than that of the stream of air in practice, the speed of this stream actually plays a considerable part in the phenomenon. Imagine, for example, a disc maintained at a temperature of 1,400 degrees by a stream of air at 2,000 degrees, flowing at the rate of 500 litres per hour. One may imagine that if the speed of the air were doubled the disc would attain a considerably higher temperature, and in excess of that which would be secured if the temperature were increased to 2,050 degrees, and the speed maintained at its former value.

In the case of the incandescent mantle, the temperature referred to is that of the flame and the jet of air is the flame itself ; the speed may be measured in terms of the quantity of heat developed per hour below the mantle.

Now the maximum efficiency of the burner always co-exists with a temperature considerably lower than that of the flame, and we are therefore led to suppose that the factor of speed (*i.e.*, quantity of heat developed per hour) is of paramount importance, especially on account of the fact that we are here dealing with a series of hydrocarbon gases of somewhat uncertain composition, the theoretical temperature of combustion of which is very variable.

A consumption of 200 litres of water gas gives rise to the development of 500 calories below the mantle, at a temperature of about 2,020 degrees. A similar consumption of ordinary town gas in the same time would lead to the development of 1,000 calories

at a temperature of 1,950 degrees. Is it therefore surprising to find that the mantle becomes much hotter in the latter case ? Clearly no.

To resume, it appears that when an incandescent burner is so regulated as to yield its maximum luminous efficiency, the temperature of the mantle, in general, depends mainly on the speed of the exceedingly hot flame and a change of a few degrees more or less in the flame-temperature produces relatively little effect. For a given consumption per hour of gas the speed (*i.e.* the quantity of heat developed per hour) is proportional to the calorific power of this gas.

In a previous series of researches on this subject carried out in 1894, I adopted another definition of incandescent illuminating power, which I then designated as the luminous efficiency, referred to 100 litres, of the gas under the following conditions :—

A No. 1 incandescent Auer burner was fed with a supply of gas at a constant pressure of 50 mm. The supply of primary air to the burner was received through a suitable measuring apparatus, and it was arranged to regulate the access of air in such a way as to secure the maximum intensity compatible with the consumption and quality of gas used, and the dimensions of the mantle.

The maximum efficiency (purely relative) corresponds to an intensity and a temperature of the mantle much less than those obtained according to the absolute definition laid down at the commencement of this article. Under these conditions the theoretical temperature of the flame does not play any material part, and the efficiency depends solely on the speed, that is to say the calorific value.

In subsequent researches undertaken by myself in 1901 and 1905, and presented at the International Photometrical Congress in 1907 I dealt with " intense " combustion, that is to say with conditions under which the temperature of the mantle, while being still very far distant from that of the flame, yet approaches much nearer to it than in the researches described above. The influence of the speed and the heat of combustion is, however, still sufficiently pronounced to enable us to conclude that the efficiency may be regarded, in practice, as proportional to this quantity.

But in such cases one can observe the effect of the flame temperature, and our conclusions, as formulated at the International Commission referred to, are as follows* :—

"The incandescent illuminating power of a mixture of illuminating gas and water gas is proportional, not to this calorific power of the mixture, but to the calorific power subject to a proportional correction of 15 per cent of that of the water gas entering into the composition of the mixture."

As I have stated above, one can, for a given mantle, and disregarding the consumption of gas, secure certain relative proportions of gas and air which enable us to measure the upper limit of the luminous intensity of the source. The figures obtained for various gases and the same mantle may be considered, up to a certain point, as being indicative of the characteristic properties of each gas studied. But the efficiency resulting in this case is not that which is important from the standpoint of the consumer.

I have demonstrated that, in the case of illuminating gas, it is in general the lightest gaseous constituents, having the lowest calorific values, which are mainly instrumental in determining this upper limit of the intensity of the burner, and which yield the highest figures ; but this conclusion would not apply to the efficiency in its industrial sense.

It seems, *a priori*, that in this case the temperature of the mantle is sufficiently distant from that of the flame to render it possible for variations in this quantity to affect the result very materially. In a word we approach the conditions characteristic of a platinum disc, which is subjected to the action of a jet of hot air sufficiently rapid to maintain temperature-equilibrium with it, and the influence of speed disappears.

* Report of the work of the Commission 1907, p. 56.

I imagine that those who feel difficulty in accepting the conclusions which I have formulated forget the distinction which must be drawn between conditions corresponding with the *absolute upper limit of intensity* and the *maximum efficiency* respectively.

The International Petroleum Commission.

(COMMUNICATED BY DR. UBBELOHDE.)

As announced in our last issue, the first meeting of the above Commission took place in London on May 24th to 26th, official delegates of all the chief European nations and the United States being present, including :

Germany—Dr. Ubbelohde, General Secretary of the Commission, Technische Hochschule, Karlsruhe ; Dr. L. Weinstein, Berlin.

England—Dr. Dvorkovitz, London.

France—Prof. Colson, Prof. Tessily, and M. Guiselin, Secretary of the Commission, Paris.

Holland — Prof. Hoogewerff, The Hague, Sluyterman van Loo, Rotterdam.

Italy—Prof. Villavocchia, Prof. Spica, and H. Cataneo, Rome.

Norway—Dr. Halvorsen, Christiania.

Austria-Hungary—Prof. Zaloziecki, Lemberg ; Dr. Böhm, Ostrau ; Dr. Singer, Pardubitz.

Roumania—Prof. Pfeiffer, Dr. Edeleanu and Dr. Aisinmann, Bucharest.

Russia—A. A. Gouchmann, Baku.

Servia—Prof. Lecco, Belgrade.

Spain—Prof. Mourelo, Madrid.

Switzerland—Prof. Bossert, Zürich ; Dr. Berguer, Yverdon,

United States of America—Dr. David Day,* Washington.

Since the Bucharest Congress, subcommissions in all the chief countries have been formed and have undertaken researches, the results of which were laid before the meeting of the Commission proper in London.

In consequence of the previous work of these sub-committees it was found possible to settle many questions in connexion with the standardization of methods of testing petroleum products ; others were referred back to the subcommittees representing the various countries for further study. A program was drawn up relating to the study of methods of testing of such general products as benzine, illuminating oil, gasoline, lubricating and cylinder oils, vaseline, paraffin, asphalt and pitch, &c.

Of considerable importance was the decision of the Congress to compile a table in order to enable the viscositymeters in use in different countries to be rendered comparable with one another ; this is the more essential, because the most extraordinary variety exists in the different types of instruments in use at present, so that it seems extremely difficult as yet to secure immediate adherence to a single international type. The researches involved in the preparation of the tables in question are to be independently carried out at at least two separate testing stations.

At the London Assembly Prof. Zaloziecki was appointed Chairman, Prof. Colson and Dr. Edeleanu Vice-Chairmen, and Drs. Weinstein and Aisinmann secretaries.

A complimentary telegram was sent both to the Honorary President, Prof. Holde, and also to the President of the third international Congress at Bucharest, Saligny. Finally, the thanks of the Commission were extended to the General Secretary for his valued services in connexion with the organization of the Congress.

The next Congress will probably take place, by the invitation of the United States Government, in Washington.

* It was particularly gratifying on this occasion to meet Dr. Day, who, it may be noted, has kindly agreed to act as one of our correspondents in the United States, and who is one of the greatest living authorities on petroleum matters.

Annual Meeting of the Institution of Gas Engineers.

The annual meeting of the Institution of Gas Engineers opened on June 15th, and a very successful gathering was held.

In our present number space does not allow us to comment upon the many important questions raised as fully as we should like, but we may refer our readers who desire further information to the full published account in our contemporaries *The Journal of Gas Lighting* and *The Gas World* for June 19th and 22nd respectively.

The proceedings commenced with the presentation of the annual report of the council. This, it may be noted, contained several items of interest from the standpoint of illumination. First may be mentioned the work done by the Gas Institution in connexion with the international standard of light, the Institution being represented by Mr. J. W. Helps (who is to be the next President).

During the past year the council, in conjunction with the committee of the Gas Companies Protection Association, have given consideration to the suggestion that steps should be taken for introducing a Bill into Parliament to prescribe a standard burner to be used throughout the United Kingdom for the official testing of the illuminating power of gas, "so that the returns everywhere in the United Kingdom would be comparable, and so that all parties dealing with gas lighting questions, from the Houses of Parliament down to the consumer of gas, would have a definite standard of comparison." This matter has been duly submitted to the Board of Trade and is now under consideration.

In passing we may also note that the Institution have under consideration a conference with architects on the subject of heating by gas. It will doubtless be felt by many that co-operation of this nature might lead to very desirable results, and it seems reasonable to suppose that similar action would be found beneficial on the subject of illumination.

The presidential address, delivered by Mr. Thomas Glover, was of more than passing interest, and illustrated in no unmistakeable manner the wide views which are taken of the functions of the gas engineer at the present day. In opening his address the President, naturally referred to the great loss the industry had sustained in the passing away of Sir George Livesey, and the decision to perpetuate his memorial by the formation of a special professorship at Leeds. He dwelt on the value of scientific research and study by the gas engineers of the present day, and expressed his conviction of the value of the training which the University is intended to bestow on those who would afterwards be called upon to occupy responsible positions. Both the scientist and practical engineer were needed, and he hoped that the University would be the means of promoting a constant interchange of scientific knowledge and practical experience between the university and the factory.

Mr. Glover also referred to the growing improvement in the labour conditions of the present day. Sir George Livesey's great work on co-partnership had been of inestimable importance in improving relations between the employer and employee, and it was gratifying to observe that the Gas Light & Coke Co. had adopted a similar system. The exacting service of the future required the most economical retorting practice which could be secured, but an equally imperative requirement was an alert, intelligent, and thoroughly up-to-date outdoor staff and administration.

The President next turned to technical matters such as carbonization and smokeless fuel, and gave some of his experiences at Norwich. Incidentally he expressed approval of the action of the Gas Light & Coke Co. in adopting a calorific test and looked forward to the time when tests of illuminating power would be superseded. Only about 10 per cent of the gas used for lighting and only 5 per cent of the total gas generated in Norwich was

used in luminous flames. Hence the importance of the photometer for ascertaining the value of gas to the average consumer was much less than in the past.

In conclusion the President remarked how great a risk a company ran if the requirements of customers were in any way neglected. It was true that gas had made very great progress, and, with a duty of 20 to 30 candles per foot of gas for ordinary pressure, and 60 candles upwards per foot for high pressure supply, the days of gas lighting were not yet over. But competitors were vigorous and active, and their artistic fittings placed the old unattractive brackets and chandeliers, the heritage of a hundred years of gas lighting, at a great disadvantage. To satisfy the educated taste of consumers was it not important that artistic fittings should be supplied on easy terms, and that new forms of gas lighting should be given a chance. The supply should be governed at the meter; the piping of the house should be sound and good, and the fittings should be light and artistic in design. Inverted burners should be used in the best rooms and, if possible, maintenance of the mantles and burners under certain conditions should be undertaken.

Among the various papers brought before the Meeting special mention may be made of that by Mr. A. Foreshaw entitled 'The Illuminating Efficiencies of Carbon Monoxide and Hydrogen used in conjunction with Incandescent Mantles.'

The author referred first to the work of several investigators who had apparently tried to establish a direct connexion between the illuminating power of a gas and its calorific value, and to the researches of Mr. St. Claire Deville on this subject.* It had also been suggested that no matter what kind of gas were used with the mantle, the point of highest efficiency corresponded with the point of maximum illumination.

Mr. Foreshaw, however, doubted whether any connexion could be established between illuminating and calorific value. Many of the experiments on which this assumption was based referred to complex mixtures of gases in various proportions and it had seemed to him preferable to make experiments on two pure gases—hydrogen and carbon monoxide. These two gases possess very similar calorific values. They differ, however, markedly in density and in rate of combustion. The result was to show that the connexion referred to above did not hold in the case of the comparisons of these two gases; in all cases where hydrogen and carbon monoxide were compared under similar conditions of aëration, the advantage had always been overwhelmingly in favour of carbon monoxide. Moreover, since with any ordinary atmospheric burner carbon monoxide might be burned with a much greater degree of aëration than it was possible to obtain with hydrogen without the flame striking back, it might be concluded that, under such conditions, carbon monoxide would give a higher maximum duty at every rate of consumption.

Mr. Foreshaw also found that the distribution of luminosity over a mantle was very different in the two cases.

Another factor of considerable importance was the effect of flame-shape. This was studied by Mr. Foreshaw by the aid of cones and hollow shells within the mantle such as have been referred to before in this journal (vol. i., 1908, p. 734). It was found that these exerted a marked influence on the shape of the flame and at the same time accelerated the process of combustion and the concentration of the flame.

Contributions to the discussion of the paper were read from M. Sainte-Claire Deville, Prof. W. Bone, Mr. Vernon Harcourt and Mr. J. W. Bray, and the discussion was opened by Mr. Thomas Holgate. We have decided to hold over this discussion, dealing with the interesting technical points raised, until our next number, when we hope to deal with Mr. Foreshaw's paper in greater detail.

In what follows we merely give an abstract of the remarks, from the

* Attention may here be drawn to an article by M. Sainte-Claire Deville on this subject, which appears on p. 451 of this number.

general standpoint of illuminating engineering, of Mr. Leon Gaster, who, as Editor of *The Illuminating Engineer*, was subsequently called upon by the President. Mr. Gaster said he regarded it as a great privilege to be present, and congratulated the Institution on having started such a valuable series of investigations. It was eminently desirable to ascertain exactly what such gases, under given conditions, were capable of performing, and he hoped that, as Mr. Bone had suggested, the researches would be extended further. There was room for much additional research on all illuminants in order to clear up many of the present misconceptions and to find out the exact capabilities of each system of lighting and assign to it the field for which it was best suited.

In order that different illuminants might be scientifically compared some common basis of comparison was necessary, and he wished to express his satisfaction at the part taken by the Institute, to which reference had been made in the council's report, in promoting agreement on an international candle. Only the day before he had received an official communication from the Bureau of Standards in Washington, in which satisfaction was expressed at the concerted action taken by the Gas Institute and the International Electrotechnical Commission in this country and he regarded this as a very valuable precedent auguring well for future co-operation.

In addition he would like to dwell upon the mode of expressing luminous intensity adopted by the gas industry. It rendered all comparison of results established in different countries very difficult when in one case horizontal candle-power was implied and in others mean spherical or mean hemispherical candle-power. The gas industry were of course quite justified in adopting measurements in a horizontal direction if they found it convenient in their own measurements, but he thought it would be well for them to bear in mind that this method was not always suited to the comparison of different illuminants, and to consider whether some common basis of testing, applicable to all sources, could not be decided upon.

The following papers were also read at this meeting:—

'Carbonization in Chamber Settings,' by Dr. Lessing.

'Carbonizing,' by Mr. J. Ferguson Bell.

'The Advantages and Disadvantages of a Hot-Coke Conveyor,' by Mr. R. Watson.

'A Comparison between the Illuminating Efficiencies of Carbon Monoxide and Hydrogen when Used in Conjunction with the Incandescent Mantle,' by Mr. Arthur Foreshaw.

'A Study in Working Costs,' by Mr. Herbert Lees.

'The Relative Capital Accounts of Gas Undertakings Owned by Companies and Local Authorities,' by Mr Arthur Valon.

Dr. A. H. Elliott in London.

Among the distinguished visitors who were present at the annual meeting of the Institution of Gas Engineers it was a pleasure to meet Dr. A. H. Elliott, who was present in London as one of the official delegates at the Seventh International Congress of Applied Chemistry, held during last month. Dr. Elliott is chief engineer and chemist to the Consolidated Gas Company of New York, one of the largest concerns of this kind in existence, and to our readers is also doubtless well known as one of the earliest and staunchest supporters of the Illuminating Engineering Society in the United States, and as the present treasurer of the Society, whose excellent financial position, it may be noted, as well as its large roll of membership, is remarkable in such a young society.

Although prominently connected with gas lighting Dr. Elliott is also an expert in petroleum, and it may be recalled that at the last annual convention of the Illuminating Engineering Society he delivered a paper describing some exhaustive tests on oil lamps as standards of light, which was reproduced in our columns (vol. i., p. 933).

High Duty Gas Lighting.

BY THOMAS HOLGATE, M.Inst. C.E., F.C.S.

A REVIEW of the present position of this subject will naturally commence by a reference to its latest development, namely, the high pressure gas inverted incandescent light. And the writer will make an examination of the efficiency of this type, the starting point for a discussion of the principles underlying the working of incandescent gas lights in general.

If he selects the Keith lamp, such as was recently installed in Fleet Street as the representative of the new type, it is because the working results thereof have been more extensively published than those of the somewhat analogous forms, in use here or in Germany. The tests of these other forms confirm the success of the principle, and thus strengthen the conclusions of the tests by Mr. W. R. Herring, Edinburgh, Prof. J. T. Morris, London, and Dr. Wedding, Charlottenburg. Of the last named group it must be said that whilst the individual tests differ in some of their details, yet they all concur in showing a remarkably good diffusion of light from the long inverted mantle of the new lamp. Whilst the ordinary inverted burner appears to advantage in the light emitted in the vertical line, as shown subsequently, and the upright burner to advantage in the horizontal rays, the new one combines in a notable degree the advantages of both. The diagrams of hemispherical distribution of light given by Dr. Wedding and Prof. Morris agree in

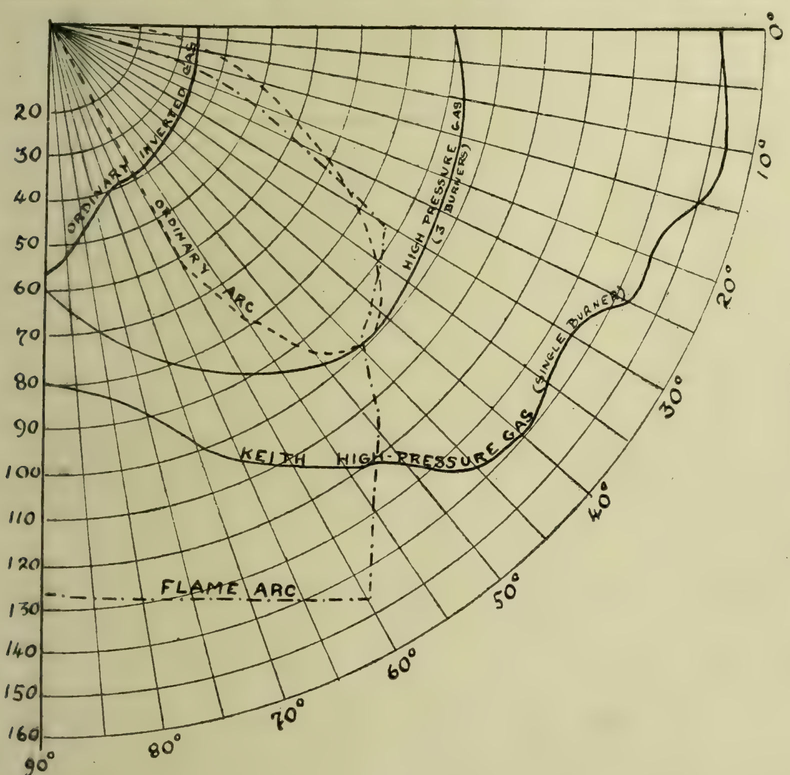


FIG. 1.—Distribution of Light from Flame Arc, Ordinary Arc, and High and Low Pressure Gas lamps.

showing that the minimum intensity is vertically under the mantle, but this is an advantage, since the distance to the pavement is at that point also at a minimum. The maximum intensity is at the horizontal, and almost equally so in the first 45 degrees below that line, which of course means a favourable emission of light to the more distant area illuminated by the lamp. It would seem indeed that this equable distribution is entitled to rank as of equal importance to the high candle-power per cubic foot of gas consumed, satisfactory as the latter undoubtedly is.

lamps, is in agreement with the results of the three tests above mentioned, and is good in spite of the unfavourable conditions that prevail. Could the lamps have been placed on refuges in the middle of the roadway full advantage of the splendid distribution properties could have been taken. As it is the lanterns are fixed upon brackets which enable the footway to be clear of obstructions, and also avoid any shadows under the lamp. Every increase in distance from the dark surface of the buildings is advantageous in utilizing the light, and is therefore to be sought for, and if need be,

TABLE I.

Authority.	Place of Trial.	Pressure of Gas in Inches of Water.	Calorific value of Gas used. B. Th. U.		Cubic feet of Gas used per hour.	Observed Candle-power (English).			Angle below horizontal.	Candles per cubic foot of Gas per hour.		
			Gross.	Net.		Mean Spherical.	Mean Hemispherical.	Maximum.		Mean Spherical.	Mean Hemispherical.	Maximum.
W. R. Herring	Edinburgh ...	61 in.	621·2	560	24·6			1683	2½°			68·4
”	”	”	”	”	22·9			1655	4°			72·2
”	”	”	”	”	24·6			1705	20°			69·3
”	”	”	”	”	22·9			1685	20°			73·6
”	”	”	”	”	24·8			1609	37°			64·9
”	”	”	”	”	22·9			1572	37°			68·6
J. T. Morris	London E. ...		About 480	—	23·3	380	640	720	0° to 30°	16·3	27·5	30·9
”	” E. ...		”	—	22·8	425	720	780	0° to 40°	18·6	31·6	34·0
”	” N. ...		545	—	23·8	680	1140	1250	0° to 40°	28·6	48·0	52·5
Dr. Wedding	Charlottenburg	60 in.	—	528·84	28·356		1224	1400	0° to 10°	—	43·16	49 37
”	”	87 in	—	568·4	33·332		1472	1674	0°	—	44·16	50·22
Summary.				Net B. Th. U employed.		Candles per net B. Th. U.		Candles observed.				
W. R. Herring	Edinburgh ...	61 in.	621·2	13,776		0·1220		1683	2½°		?	68·4
Dr. Wedding	Charlottenburg	60 in.	?	14,969		0·0935		1400	0° to 10°		43·16	49·37
”	”	87 in.	?	18,933		0·0884		1674	0°		44·16	50·22

Diagram No. 1 may be compared with those on p. 630 of *The Illuminating Engineer* of August, 1908, and together they will be found to elucidate the light distribution of the ordinary pressure and the high pressure inverted burners—single and triple; the electric arc, and the electric flame arc.

The flame arc has a low horizontal emission, with a large vertical output, diminishing suddenly at 56° below the horizontal whilst the rays from the arc light are almost exclusively in the segment between 10° and 60° below the horizontal.

Observation of the uniformity of lighting in Fleet Street, by the Keith

obtained by the use of longer brackets. The colour of the light betokens high temperature, and with it a comparatively high efficiency in light radiation, but it is without the dazzling effect that would be injurious to the eye, and that would require toning down by frosted glass or opal screens. As the only intervention between the mantle and the surface to be illuminated is that of clear glass the whole of the light may be used effectively, both as to its intrinsic brightness and as to the before-mentioned suitability of its diffusion.

As to the lighting power per cubic foot of gas, and per British thermal

unit employed, these can best be understood by a tabulated statement embodying the available data. The writer has to thank each of the three experimentalists for information that has enabled this table to be computed upon lines that are in some degree comparable. The table would have been more useful had the gross and net calorific values of the gas been given in each instance.

In the summary, the three most comparable tests have been placed in juxtaposition and the efficiency per British thermal unit (net) calculated. Why Dr. Wedding's results are not equal to Mr. Herring's cannot be explained without further information as to the calorific value of the Charlottenburg gas. The figures relating to the calorific values of the Edinburgh gas are quite consistent with the illuminating value, but the same cannot be said of those given by Prof. Morris for the London gases. The usual quality of the gas in East London is 563 B.Th.U. gross and 501 net, while in the North of London it usually has 581 gross and 518 net. It is therefore impossible in the light of these figures and of those in the table, to bring Mr. Morris's results into a classification based upon efficiency per B.Th.U. (net) employed. Why should the Edinburgh results exceed those of Charlottenburg by over 30 per cent efficiency ? There is nothing in the preceding table to explain the fact, neither is there anything to invalidate it, but the greater proportion of its heat due to carbon shown later should not be overlooked. The Keith lamp obtains some of its superiority by the preheating of the air, and if two different qualities of town gas require different volumes of air for their combustion then the share of the heat recuperation in the general economy will be affected. Any slight increase of temperature thereby secured will be followed by a much greater percentage increase in the radiation of light from the mantle, such increase being not less than the fifth power of the increase of the absolute temperature.

But besides this possible explanation it must be noted that our knowledge of the behaviour of gases of diverse composition, at these high temperatures, is but small, although likely, from various quarters, to receive some elucidation ere long.

TABLE II.

Inverted burner tested.	Globe used.	Pressure in ins.	C. ft of gas per hour.	Air ports.	Candles per cubic foot of gas at angles below horizonal line.										
					0°	10°	20°	30°	40°	60°	70°	80°	90°	Average.	Ratio of vertical to horizontal.
A large	None	2·5	3·5	fully open	16·7	15·8*	—	17·8	18·1	19·7	20·0	23·4	28·7	20·02	1·72
A small	Clearglass with hole in base.	2·5	1·65	fully open	13·0	11·7*	—	14·0	14·8	17·6	18·5	22·1	25·2	17·11	1·94
B large	None	2·0	3·5	half closed	13·9	13·0	13·0	13·9	16·6	18 7	21·6	22·5	25·7	17·56	1·85
B small	Clearglass	2·0	1·5	half open	12·3	12·3	12·3	14·0	14·6	18·2	24·2	24·2	25·2	17·33	2·05
C	None	2·4	3·7	fully open	14·9	13·7	13·8	16·9	16·9	19·8	22·7	25·1	31·8	19·51	2·13
Averages		2·28			14·16	13·2	13·2	15·32	16·2	18·8	21·4	23·46	27·32	18·305	1·94

NOTES :—* These observations were at 12°. The gas consisted of 70 per cent coal gas and the rest carburetted water gas; its illuminating power in the No. 1 London Standard Argand was 3·118 candles per cubic foot, except for the first series, when it was 3·16.

Mr. Morris, in replying in *The Gas World* to some observations upon his results, explained that every opportunity had been given the makers of the lamp to adjust the pressures, and the nipples for admission of gas, in each separate test. As his figures show a considerable divergence from those of the other experimentalists, and as he drew attention to what appeared to be vagaries in his own series of tests, it will be well to take each factor separately, that might be the cause directly or indirectly of such conflicting results. What many

of these factors are, will be seen in the subjoined record of tests of present day inverted burners upon the authority of Mr. Thos. Glover, Gas Engineer, Norwich. The Table II. has been compiled by the writer to serve also as a means of comparison of the light distribution of low pressure inverted with that of the high pressure inverted already given.

The distribution of light in the five series of tests, shows the maximum effect in the vertical line, averaging almost twice that of the horizontal. The minimum effect is at about 15°, whilst the average is at about 60°. The maximum is on the average a little over twice the minimum, which latter is about 72 per cent of the average. The average efficiency per cubic foot of gas was almost equal in the last series to that in the first (when the difference in the quality of the gas is allowed for), the mean of the two being 19·765. That of the remaining three closely approximate to 17·33, and this resemblance directs attention to the quantity of gas consumed, and the relative amounts of air admitted. The third series would appear to be worse than the first by reason of a lesser ratio of air; whilst series two and four using almost similar quantities of gas (being both on small burners), probably suffered from the relative smallness of their flames and mantles.

Whatever conditions are necessary to secure maximum efficiency, are those which ought to be embodied in any complete report upon the testing of any incandescent gas lamp, and must be known if the lamp is to be properly fixed, adjusted and used to the utmost economy.

1. *The Quality of Gas.*—This can only be fully reckoned with when an analysis of its chemical composition is provided, in addition to the illuminating power determined in the No. 2 Metropolitan burner, and the gross and net calorific values. But inasmuch as the analysis occupies some little time, it frequently becomes convenient to ignore that portion and trust to the remainder of the data. It is desirable to have both calorific values, because although the relative utility of gases for incandescent work follows the net rather than the gross, yet the difference in figures between the two values will give an indication as to whether there is water gas in the mixture. That is important in two ways. Firstly, it will give some idea of the specific gravity of the gas, and secondly, it will give a hint as to the proportion of air required for complete combustion. Taking the calorific values per cubic foot of gas measured at 60° F. and 30 in. mercury, pure water gas has the following figures :—

	Specific gravity compared to hydrogen	air	Volume per cent	B. Th. Units gross	B. Th. Units net	Difference	Volume of oxygen required
Hydrogen	1·	0·069	54·72	×325=177·84	×272=148·84	29·00	27·36
Carbon monoxide	14	0·969	6·76	×323= 21·83	×323= 21·83	0·00	3·38
Methane	8	0·553	34·75	×1008=350·28	×902=313·44	36·84	69·50
Unsaturated Hydrocarbons	21	1·453	3·77	×2343= 88·33	×2184= 82·34	5·99	16·965
Average	5·066	0·3505	100·00	=638·28	=566·45	71·83	117·2(5

The difference figure 71·83 × 6·14 = gross B. Th. U. due to hydrogen, viz. 441·25 or 369·42 net, leaving 197·03 due to carbon.

A sample of coal gas similarly works out as follows :—

	Specific gravity to H.	to air	per cent by volume	B. Th. U. gross	B. Th. U. net	Difference	Oxygen required
Hydrogen	1	·069	50	×325 = 162·5	...... ×272 = 136·0	26·5	0·25
Carbon monoxide	14	·969	50	×323 = 161·5	...... ×323 = 161·5	nil	0·25
Blue Water Gas	7·5	0·519	100	= 324·0	297·5	26·5	0·50

⁎ Oxygen required 0·5 cubic feet or air nearly 2½ cubic feet. Net heat developed per cubic foot of oxygen = 595 B. Th. units.

These figures are very significant, showing that a non-luminous gas will give out more heat than a luminous gas, *for a given consumption of normal air.* It is of course important to note the italics, and when that has been done, the preceding figures will go a long way to explain why it occurs in practice that with a given burner or with a given supply of air, an increased illuminating power is obtained by decreasing the gas supply, or better still by diluting the coal gas with water gas. Further with the same diameter of gas orifice and pressure thereat such admixture would diminish the actual flow of gas, because the average specific gravity would be raised.

Sometimes uncarburetted water gas is mixed with coal gas in suitable proportions, but more frequently for town supply carburetted water gas is so employed; but that fact does not invalidate the basis of the above comparison. The essential fact to be observed is that variation of composition not only affects the calorific value per cubic foot of gas, but affects the proportion of air required. It is therefore desirable that the quality should be as uniform as possible in any one district.

Hitherto the admixture of water gas has given rise to the greatest of the variations experienced, but it is most probable that in future the admixture will be arranged to be in such proportions as will produce a more uniform mixture than has ever been delivered. In other words, to lessen variation rather than to increase it. As evidence that experience has shown the necessity for this, I quote Mr. Atkinson on gas engines, before the Institution of Mechanical Engineers. He said : "the constant and great variation in the calorific value of the gas which during the last two or three years has constantly fluctuated from less than 500 to over 600 B.Th. units (net) per cubic foot as tested in a calorimeter, often varying thirty or more units during a test, and larger amounts from day to day.

(*To be continued.*)

A Visit from Dr. E. P. Hyde.

During the last month we have received a visit from Dr. E. P. Hyde, whose interesting description of the laboratory formerly under his charge at the Bureau of Standards (*Illuminating Engineer*, vol. i. p. 761) will be fresh in the minds of our readers. Dr. Hyde has been making a tour in this country and on the Continent in order to gather information with a view to the equipment of the laboratory of the National Electric Lamp Association in the United States with the organization of which he has been entrusted. An important feature of this laboratory, on which special stress may be laid, is the scheme of co-operation between those interested in different aspects of illumination. The work of the laborafory will deal with illumination in all its branches in a wide manner, and Dr. Hyde will have the assistance of experts connected with the engineering, physical, physiological, and other sides of the subject, so that, it is hoped, general results of great importance will be obtained under Dr. Hyde's able guidance.

While the subject of the international unit of light is receiving so much attention, it is interesting to recall the great services which Dr. E. P. Hyde and the Illuminating Engineering Society have rendered to the movement. His paper on 'Primary and Secondary Standards of Light,' read at the Annual Convention of the Illuminating Engineering Society in 1907, is still a concise and lucid exposition of the distinction between units and standards and the conditions under which different types of standards are most advantageous, and we gladly make reference to this paper as a matter of historic interest.

The Worship of Light.

By Dr. M. Gaster.

(*Continued from p.* 373.)

We are now proceeding to the monsoon swept plains of India, with the snow-clad crests of the Himalaya ranges frowning over the lands below. No longer the unclouded skies of Egypt nor the fierce beating down of the rays of the Babylonian sun, but continual changes of temperature and of climate, changes of seasons, of light and dark, of drought and flood. The demons of the air, the enveloping clouds which swallow up the light of the sun and prevent it from shining upon the world, now also enter into the worship, and share in that offered to the sun. To propitiate the evil spirits in the air, is felt to be as great a necessity in India as it was to propitiate the evil spirits of the earth in Babylonia and Egypt. But the central figure and the object of greatest veneration remains the sun. The whole of the elaborate ceremonial which meets us in the worship of the Brahmins has its centre and explanation in the worship of the sun in its manifold appearances, as the sun of the dawn, as the sun of the noontide and of eventide, as the sun of the four seasons of the year, and the sun fighting the demons which threaten to destroy it. It was a great achievement of late Prof. Max Mueller to have given the most comprehensive explanation of the ancient Indian ritual and mythology by connecting it with the worship of light, and especially with that of the sun, and to have shown that the great Pantheon of India could easily be reduced to a few prominent gods, who are all nothing else but representations of the sun and of atmospheric conditions.

The unclouded radiant sky appealed strongly to their imagination, and thus it came about that the names of their gods are derived from it, and that their prayers centre round the radiant sun. But India has developed from early times a school of deep thinkers and metaphysical hair splitters, a kind of mystical philosophy, in the light of which they used to interpret their ancient beliefs and practices in such a manner as made it difficult to get to the bottom of these beliefs and practices, or to explain their ceremonies. But now it is made manifest that their Brahma and Indra and Vishnu and Shiva, like the gods of the Greek mythology with which they show a remarkably close analogy, are sun-gods and little else; and that their Vedas or their religious hymns were originally addressed to the personification of the deity, the radiant sun. This is not the place to dilate on the many myths and tales connected with this religious system, but it is of interest to notice that the modern interpretation of the Indian gods has helped us better to understand the classical mythology of Greece and Rome, with which we are more familiar, and the true meaning of which had, however, not been disclosed until quite recently.

Before coming nearer the West and the sources of European civilization it is instructive to glance for a while at the religion of light which Ormuz (Ahuramazda), the god of light, as opposed to Ahrsman, the god of darkness, revealed to his prophet Zoroaster, which is known as the religions of the ancient Persians, or Mazdaism. In this system the primitive ideas have become more spiritualized, and we are confronted with a religious conception which recognizes two divine powers of almost equal importance, and worships the light and the darkness as two equal divinities. Darkness is permanently at war with light, and at the end of days light will triumph.

Side by side with it there arose in Asia Minor and spread over Europe, another and more pronounced form of the worship of a personified god of light, himself light, the cult of Mithra. Here the popular belief was beginning to turn off the main road and to become the cult of the initiated or the "illuminated." Let it be noted in this connexion that henceforth the founders of sects and the select would call themselves the "illuminated"—those who were favoured to see the light, and to spread the light. The central figure of these mysteries, as they are called, is the god Mithra, an unmistakable personification of the sun, usually depicted as a young man with the Phrygian cap and with varying emblems, symbols of the sun, in its manifold aspects. The best known emblem is the bull, the symbol of fertility and strength, stabbed by the god; at the feet of the bull a snake is coiled up, a dog laps the dropping blood and a scorpion's shears pinch the lower part. These represent the action of the sun in its strength and decay, and the influence it exercises upon the world in summer and winter, in the time of the solstices and equinoxes.

But we are not to linger on a refined symbolism. It is as far removed from the primitive worship of the sun as the centre of light and fire as is the latest speculation on the electric arc from the primitive firebrand or pine-wood torch. Let us turn rather to the ancient Greek cult with its infinite number of gods and goddesses, with its heroes and mighty men, with its wondrous tales and curious ceremonies. Greek poetry and art have so successfully transformed the rude primitive beginnings and have so thoroughly changed the outward appearance of the objects of worship that it has not been an easy task to find the thread of Ariadne in this mythical labyrinth. It is now, however, perfectly clear and undisputed that even the very names resemble those given by the Indians to their divinities, and that they are primarily to be understood as personifications of the radiant sky and the golden orb, the sun and its rays in the different seasons of the year, and in its circuit through the various stations in heaven until it completes the round, known as the year. The new born sun at springtime, and the dying at the beginning of autumn, the burning shafts of the summer sun and the cold gleam of the winter are represented by as many gods and goddesses, Zeus, Apollo, Bacchus, Diana, Proserpine, &c., are mere names.

The festivities connected with their celebrations are unmistakable in their meaning. Hercules performing his twelve labours is the embodiment in a human form of the sun passing through the twelve signs of the Zodiac, and just as the sun enters a different constellation in each succeeding month, so does Hercules perform another exploit. But in Greece the original meaning of the underlying belief had been thoroughly transformed, and the poetic imagination of the Greeks has invented many legends or, borrowing them from the East, has adapted them to their own genius in so perfect a manner that, fascinated with their incomparable beauty, one loses sight of that one feature which they all have in common, viz., that they are idealized forms of the worship of light, and that light is the very essence of life.

Going further West in advance of the sun, we shall find at the root of the various forms of religious ceremonies an intimate connexion with, and close dependence upon, the sun. We are not so well informed of the worship of the Druids in Gallia and ancient Britain, but the monuments which they have left behind offer us a clue for the understanding of the ideas which governed the ancient forms of faith in these countries, and at the same time close the ring of our investigations. By a long road we return to the very point from which we started. Huge single stones, monoliths in various shapes and forms, are found scattered singly or in rows all over the three continents, and, if we are to believe reliable travellers, are found also in some parts of Central America. A few years ago they were discovered among the famous ruins of the Zimbabwe in the South of Africa. The unanimous opinion of scholars has been that these very

stones were remnants of ancient forms of the worship of the sun, moon, and stars. The Cromlechs and Stonehenge, as they are known in England, belong to the same category, and are the last remnants of that old worship of light. The boulders, often brought from a great distance and raised with infinite pains and extraordinary skill, are the most primitive forms of the worship of the sun. The top of the stone was to catch the first rays of light long before the surroundings were lit up. They are then the markers of time, and by the length of the shadow indicate the exact position of the sun in the sky.

Recent researches have now proved beyond a doubt that there had been a definite reason for placing them in the positions in which they are. Correct calculations of an astronomical nature decided that position. By their orientation they indicate the position of the sun in the course of the year's travel through the sky. At a certain moment the rays of the new sun were expected to strike it or one of the stones erected in a circle, imitating thereby the orbit of the sun and the change of its position in the different months of the year. That moment which marked the beginning of the year was also the date for the most important religious ceremony. The whole calendar depended on it, and with it often the life of the chief priest. The nations in the North of Europe were less subtle than those of the East, and took the symbolism of a dying and reviving god more literally, and since the arch-druid or chief priest represented that god, he was also expected to die and to come to life again in his successor, who obtained the chieftainship by slaying his predecessor.

The new light that came to the world, the new sun that shone upon it at springtime had to be symbolized by a new representative upon earth, by a new arch-druid or by a new priest, who had to worship and bring sacrifices at those rude stones. Those huge and massive stones, erected as the pillars of worship, have then also undergone a change which runs parallel to the change in the worship of light. From primitive rude conceptions, man has progressed to higher spiritualization of light in the widest sense. Similarly in imitation of the myth according to which man formed out of the earth was licked into some shape; those old stones were also slowly licked first into rude human shaped monoliths, until under the hand of the Greek artist they became statues, the delight of man. The harmony and beauty of heaven and the light from above had entered the mind and illumined the spirit, and out of the worship of the light arose the worship of the earthly representative of the divine in human form. By placing these two phases of the development of this universal worship of light side by side we recognize therein also the progress made by man in his desire to spread light and to give it a permanent abode in his own life. We are now approaching the second stage of that development when the light is no longer the exclusive property of the gods. Daring spirits steal it from heaven and give it to man; and from being an object of worship, light now forms part in the religious ceremonies. Instead of worship of light we shall study in the next article "light in worship."

Fused Bifocal Lenses.

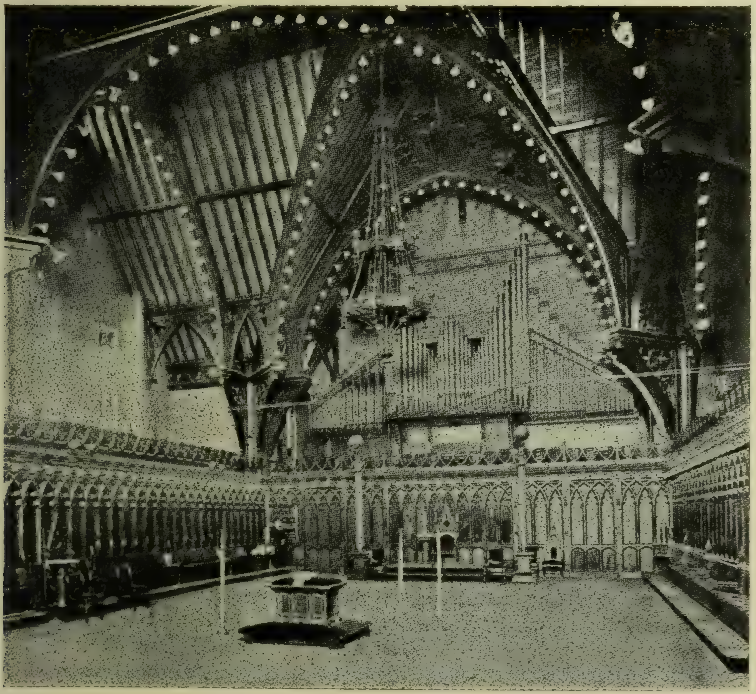
On Thursday, June 17th of this year, a paper was read on the above subject before the Optical Society, London, by Mr. Val Mackinney.

Mr. Mackinney described in detail the manufacture of such lenses, which at present are mainly utilized for spectacle glasses, with the object of providing two powers for near and distant vision respectively; this is accomplished by melting a lens of different refractive power into the lower part of the main spectacle lens.

An interesting discussion ensued, in which Mr. J. S. Dow, as a representative of *The Illuminating Engineer*, took part, pointing out the possible application of the process to optical instruments including certain forms of photometers, where, of course, a very sharp dividing line between the photometrical surfaces was needed.

The Illumination of a Masonic Temple.

THE following illustration shows the lighting installation at a Masonic Temple known as the "Aurora Grata" in Brooklyn, New York. The illumination was originally accomplished by heavy chandeliers, but eventually these proved inadequate and the plan of adding fifty candle-power tungsten lamps, equipped with suitable concentrating Holophane reflectors, was resorted to.



The method of widely distributing small units favours a well-diffused illumination, and, as the lamps are placed high, and are, in addition, provided with frosted tips and with concentrating reflectors covering the naked filament, the general effect is said to be very soft and pleasing.

The method of lighting employed has also been chosen with the object of obtaining certain decorative effects. The lamps outlining the various arches are alternately white and red and there are also 136 red, white and blue lamps down the sides of the room. All these coloured lamps are on separate circuits, and can be regulated by dimmers. The variety of effect thus rendered possible is said to be a very desirable feature in connexion with the celebration of masonic rites.

The Lighting of Factories and Workshops.

(Extracts from Annual Report of the Chief Inspector for the year 1908.)

We have frequently had occasion to refer to the lighting of factories and workshops in our columns, and in our last number we were able, through the courtesy of M.H. Chief Inspector of Factories, to give some particulars of the legislation in this country bearing on the matter.

The recently issued annual report referred to above is of considerable interest in this connexion. It is satisfactory to note that the subject of illumination is made the subject of frequent reference, and there is reason to believe that the general public is coming to appreciate more fully the importance of giving this matter the same careful consideration that is bestowed on ventilation and sanitary conditions. It is very gratifying to learn from the reports of some inspectors that the lighting of factories seems to be improving, although the evidence of others makes it clear that it often still leaves much to be desired. Some remarks of Miss Paterson, one of the lady inspectors, are of interest in this connexion :—

"In no respect," she says, "has more advance been made than in the artificial lighting of factories and workshops. I wish this could be said with respect to the natural lighting, which is of more importance than is realized. The introduction of incandescent gas light and of electric light has not only given the workers better light, but has done so without too greatly increasing the temperature, vitiating the air, or leaving a sooty deposit on walls and ceilings. Of course, it is much best to have the lighting agent not also a heating agent, but in the workrooms where ordinary gas burners are used for lighting, for even an hour or two in the day, the introduction of other means of heating is often resisted. The enforcement of the heating provision of the Act seems to resolve itself largely, in the South particularly, into a warfare against unsuitable means of lighting."

Several inspectors suggest that it is desirable that daylight illumination should be invariably used as far as possible, and the remarks of Miss Newton on this point are as follows :—

"The rooms were generally well lighted, this being necessary in order to ensure careful work. It seems a pity, however, that one cannot forbid artificial light being used at times when daylight is available, and I found not a few rooms so constructed or situated as to render it impossible for the sunlight to reach to all parts of them. The air was then usually vitiated by gas fumes, but, even where electric light is used, the workers must be affected to some extent by being deprived of the health-giving properties of sunlight. The kind of artificial light used was often undesirable, especially in tailor's factories and workshops, where, as a rule, one finds a large flickering fantail burner close to the head of each worker, which must be injurious to her sight and general health, and which renders the air of the room very impure on account of the large amount of gas consumed. Electric or incandescent gas lights have in a few cases been substituted, with good results, though the workers have at first protested against the innovation, feeling that it was necessary for each to have her own burner."

Miss Paterson also comments upon the fact that ventilation and lighting are closely connected. In this direction progress has also been made, though several bad cases are recorded, notably one factory in which samples of air proved, when analyzed, to contain as much as 32·8 parts of CO_2 per 10,000.

The bad conditions of the air in factories were attributed by the inspector partially to the fact that in the early morning the gas jets were lit,

and this had the effect of heating the rooms to some extent, but at the same time vitiating the air. It was stated that the factories in this case had been built recently, but no proper means of heating had been prepared, and the system of ventilation appears to have been very unsatisfactory.

As an illustration of the bad results to health which followed in this case mention may be made of the experience of Dr. Legge.

Dr. Legge examined fifty-six women in one room with regard only to the presence or absence of anæmia. Excluding four cases, in which evidence was doubtful, of the remaining fifty-two, twenty-seven (about 52 per cent) were notified as obviously anæmic, and twenty-five as not so affected. Among the twenty-five noted as not anæmic five had been employed for three months or less (one had only started on the previous day); whereas of the twenty-seven obviously anæmic, only one had worked three months or less. Dr Legge considers that this shows that anæmia was not prominent among the workers on entering employment, but that it must have been developed by the vitiated atmosphere of the workrooms. Even worse cases, however, are on record.

In commenting upon the arrangements in laundries Miss Patterson again remarks :—

"The cottage type of dwelling, with its little steep staircase, its dark corners and narrow doorways and passages, does not make a good laundry. It is, I suppose, natural that in the badly equipped laundry one should find the persons in charge less well equipped for their duties than those in the well organized businesses, but it is certain that where the machinery is crowded in badly lit corners which it does not fit; when the atmosphere is permeated by gas fumes, and passages which do not permit of easy movement, and when the workers are crowded on to each other and to the machines, the danger of an accident occurring is increased, partly because all this confusion does not tend to intelligent work or coolheadedness, and partly because the confusion seems to have extended to the minds of those who direct the work, and guards are badly fitted, cleaning badly arranged for and workers badly taught."

Several inspectors mention the absence of suitable washing accommodation for workers, and also point out that in many cases it is complained that, when such arrangements are provided, they are not properly appreciated or taken advantage of. This again seems to be a matter which is probably largely influenced by the existing illumination. Naturally people who live and work in gloomy, dim surroundings are apt to neglect personal cleanliness much more than those who work under a good illumination, such that any defects of this nature are easily detected and observed by others. It need also hardly be pointed out how necessary it is, in the case of a laundry, concerned with cleaning processes, to be provided with a suitable illumination which enables workers to see when an article really is clean or no.

The investigation of Miss Squires and other inspectors seems to lead to the conclusion that the great majority of accidents which occur are due to either "ineffectual guarding, cleaning machinery in motion, or too closely crowding together of the machinery." We have emphasized the connexion between bad lighting and accidents, and the above remarks of Miss Paterson show that this connexion is now felt to be well grounded.

An interesting suggestion by Mr. Wilson, of Glasgow, illustrates the possibility of light, wisely applied, serving as a preventative to accidents. He draws attention to the danger of accidents owing to workers, whose attention is concentrating on their work below, failing to become aware of a travelling crane and the load carried by it. It is suggested that although the gong is sometimes satisfactory as a method of giving warning in such cases, it is not so in a boiler shop where constant hammering is going on, and Mr. Wilson points out that it might be desirable to equip the crane with a strong electric light so that its approach would give satisfactory warning, even if the worker's back was turned towards the light, because the rapid shifting of the

shadows caused thereby would warn him of the crane's approach.

Another point in connexion with the lighting in factories on which we have previously commented is the effect of illumination on eyesight, especially in the case of close and trying work. The remarks of Miss Squire in connexion with certain "burling" departments in Yorkshire textile factories illustrates this.

"In many cases," she says, "these had escaped examination by the certifying surgeon, and in others, the nature of the work not being communicated to him, the conditions of the eyes had not been noted. The work requires close application, and the examination and repair of a dark cloth in a bad light is most trying. Girls with weak and defective sight were found burling. These, on examination, were either refused by the certifying surgeon until they had been treated, or glasses were ordered and immediately obtained. In the stress of hastily providing sufficient room for increased need for burlers, wholly inadequate arrangements for lighting in many cases had been made. On Miss Lovibond's suggestions various improvements, including insertions of skylights, in dark corners, were in some instances made. Sometimes, however, we are met with indifference or reluctance to spend money on this condition for healthy working, *and we have no statutory provision to rely upon*."

These remarks again show how necessary it is to persevere in the education of the general public, in order that the grudging of expenditure of money in this way, which is really based on a most short-sighted attitude even from the standpoint of expediency, may disappear. It may be repeated once more, that in the majority of cases the trifling expense entailed in putting the lighting on a satisfactory basis would be small in comparison with the gain and quality of the output of work following such improvements. The absence of statutory provision, which is also commented upon, will we trust be remedied in the near future, though naturally it is necessary to enter very closely into these conditions in framing recommendations on this point.

The report of the electrical inspector mentions one subject which received detailed attention in the report for 1907. In this report the dangerous nature of certain kinds of electrical hand lamps was pointed out. The danger arises through the metal work surrounding the lamps becoming live. A person carrying the lamp is then liable to come into contact with this live metal work, and may, at the same time, be standing on a damp floor or on metal plates, and so complete the circuit, and receive a severe shock. If the earth-contact is good, such a shock, even at such pressures as 215 and 250 volts, may prove fatal. This is the more likely to occur, because the effect of a shock is to cause the person holding the lamp to be unable to release his grip, and so continue to make contact with the live part.

Precautions should, therefore, be taken to avoid such conditions of insulation as may cause this framework to become live. In the present report it is stated that several firms have now designed a special portable hand lamp to comply with the conditions of safety outlined by the electrical inspector, and their enterprise is said to have been rewarded by a considerable number of orders.

Instruction in Illuminating Engineering.

Prof. W. E. Barrows, of the Armour Institute of Technology, at a meeting of the Chigaco Illuminating Engineering Society, on May 13th, dwelt upon the value of illuminating engineering education. He explained that a short course on this subject was established at the Armour Institute in 1907, and it was also stated that a course intended specially for architectural students was in contemplation.

In the course of the discussion reference was made to the work of Wisconsin University, who had established an elementary course on illumination as far back as 1896.

A Standard of Daylight Illumination of Interiors.

By P. J. Waldram, F.S.I.

Whilst the tendency of modern conditions of life and work is to multiply the number and complexity of indoor operations, and so tax to an increasing degree the eyesight of all classes of the community, the increased size of buildings in towns and suburbs enhances the difficulties of the problem by diminishing the area of sky available for daylight illumination.

The subject is of such importance that it is not too much to say that the proper lighting of schools, libraries, offices, factories, shops, and warehouses ought to be subject to public control as being a matter vital to the present and future interests of the race. It is certainly quite as important as many of the matters now controlled by rigid local by-laws.

One of the first results of the recently instituted systematic medical examination of schools has been to draw attention to defects of lighting; and rightly so, for if any illumination ought to be the subject of supervision by experts, it should be that under which the delicate eyes of children are first subjected to the continued strain of reading and writing.

There are many evidences that the popular as well as expert interest is being aroused in questions of proper illumination—both daylight and artificial. In the cure and prevention of disease, the value of ample daylight is now widely recognized; whilst the whole trend of modern domestic architecture bears testimony to the general desire that windows should be designed to light rooms rather than to decorate exteriors.

There are good reasons for the fact that the ideas of the average person on the subject—important as it is—should be extremely vague, and only to be expressed by indefinite generalities; but it is strange that architects and illumination experts, to whom the public would naturally look for guidance, should be very little better informed, and that no such thing as a general standard of daylight illumination should exist. Out of a hundred men capable of designing the proper artificial illumination of an interior it would be difficult to find one who could say what average illumination would be given by any particular size, shape, or area of a window, or what difference would be made by any given design of obstruction to the visible horizon—by the use of various colours in the interior decoration—or by any other of the determining factors.

Although interior daylight illumination is capable of very easy measurement and standardization, it is by no means easy to estimate by casual observation, because the human eye has many unrecognized limitations and unconscious prejudices, frequently the obvious result of having been trained through countless ages to the necessities of out-door life. It will note and measure for instance the small ranges of illumination between dawn and sunrise, and between sunset and dark—but it is indifferent to, and even unconscious of, the very much wider ranges between sunrise and sunset.

Prehistoric man doubtless found it very important to note the proper times to wake up and start work or hunting, and to seek a shelter for the night but the pupils of his eyes were not asked to notify him of the fact that they were—by gradually opening and closing—reducing to a more or less common level the visual sensations received from large variations in illumination during the day.

This insensibility of the eyes to large variations of diffused daylight is seldom recognized, because of the eye's extreme sensibility in the presence of artificial illumination—to the use of which it is still comparatively

unaccustomed. When one finds that under artificial light the reading of small print is, say, impossible at 0·1 candle-feet, difficult at 0·2, easy at 1·5 to 4·0, difficult at 6·0, and impossible at 8·0, it is hard to realize that under diffused daylight scarcely any difference can be detected on printed paper between 5 and 500 candle-feet. This fact alone would be sufficient to make the eye quite unreliable as a measuring instrument for comparing the relative daylight illumination of different rooms at different times and seasons, but there are many other misleading prejudices to be taken into account; as for instance with regard to the reflecting value of different colours in wall papers and the relative value of light from different angles of altitude. The obvious value of an unobscured horizon to a prehistoric dwelling or shelter gives us to-day the strong but often incorrect impression that if plenty of clear sky can be seen from the windows of a room, then that room is and must of necessity be well lit, irrespective of whether the window be broad and low, or high and narrow. It often needs ocular demonstration to convince an average committee of the superior relative value of high angle light before they will believe that to lower the ceiling and window heads of a schoolroom by a foot may decrease the daylight illumination by 50 per cent. The immensely superior lighting capacity of high windows or lantern lights is almost unknown—nine people out of ten looking at the dull stone interior walls of the Strand Law Courts would consider them as an example of very poor lighting—whereas really the unusually high windows illuminate the desks and tables where small print has to be read to a degree far superior to that of many apparently well-lit offices. The writer recently had occasion to measure the daylight illumination of two offices, A and B, in Westminster. Both were lit from the same aspect, and they had approximately the same proportion of window space to floor area. Office A on the first floor had a high ceiling and high windows, but its horizon was so badly obscured by surrounding buildings that the sky could only be seen from a standing position when the observer was close to the window. Office B, on a high top floor, had low windows, but an absolutely unobstructed horizon. The two rooms were measured within a few minutes of each other on a windless day, with a uniform grey sky, and were found to enjoy equal illumination at table height. A similar instance occurred last year. An engineer who required the best possible light for his draughtsmen, moved his offices from a lower floor, facing a dirty, but distant flank wall, to rooms on a higher floor with lower window heads, but a splendid view over the Embankment Gardens. The new situation was in the summer a matter of congratulation from his clients, and the envy of his professional friends, but the effect of the lower ceiling and window heads was very quickly felt by his draughtsmen on autumn and winter afternoons, and his bills for artificial light were substantially increased.

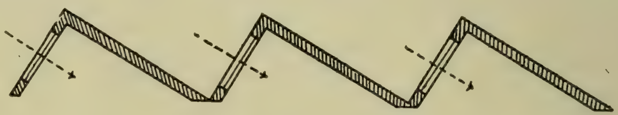


Fig. 1.

That a top skylight gives to a room quite an hour's more working light—night and morning—than would be afforded by the same area of glass in ordinary vertical windows is a fact which can be observed in many a public library having similar rooms lit by each method, but very few people appreciate it.

Many factory roofs are built with one steep and one flat pitch (see Fig. 1). The steeper sides are glazed and face north to secure an equable light. If the flatter pitches were turned to the north a much greater quantity of light would be given by a smaller amount of glazing, and it would be of an even more equable character because a

workman facing south would not then stand in his own light, as he does at present in any factory lit with a steep north light.

In previous articles* I have described how the daylight illumination of an interior can be measured in spite of its necessarily fluctuating character by taking advantage of the fact that it is always a constant proportion of the outside light at all times and seasons, except when the room is lit by the direct rays of the sun or directly reflected rays. The necessary measurements as described therein are extremely simple, and being merely comparisons they do not require an exactly calibrated or standardized photometer, but merely one with a lamp which can be relied upon to remain constant for the few minutes required for the double reading, inside and outside. They are also very quickly taken, some 50 or 60 observations at the different important points in an ordinary elementary school with, say, ten or a dozen class rooms can be made and recorded by one operator in about an hour without assistance.

When the average daily range of sky brightness for each month in the year is known, and a proportion of that brightness received by any part of an interior has been measured, it is easy to ascertain the average number of hours per day during which any given minimum illumination will be enjoyed by that part of the interior. It is also found that window efficiency and the effect of any given obstruction to it can be readily measured on scale models, and by this means any given loss of light can be expressed as the additional number of hours of artificial lighting necessary for any given purpose. Also in the case of new buildings in crowded situations the prospective illumination of rooms lit by light wells, long corridors, &c., can be tested in a model before building is commenced or the plans decided upon. Of course, owing to the large range of outside illumination, even a badly lit room will enjoy more or less sufficient light over some period of every ordinary day; and every room, however ample the window space, requires artificial light between sunset and sunrise. But it is also obvious that the average proportion of daylight received by a room may be so low that its period of good lighting is unduly restricted.

A rough working rule would be that all parts of a room should have a minimum illumination of 1 candle-foot between sunrise and sunset throughout the year, except on foggy or unusually dark days, but this would be too much to expect in some cases, and possibly insufficient in others. For instance an office enjoying a proportion of 0·001 of the outside illumination in the centre of the room might be regarded as reasonably well lit; but the desk of an elementary school receiving only that proportion would be generally considered as an insufficiently illuminated position for a child to work in, in spite of the fact that during ordinary school hours it would only drop below 1 candle-foot on foggy or unusually dark winter days, and at all other times it would be receiving a much higher illumination.

Although it is difficult to lay down hard and fast rules, it is obvious that the more completely existing buildings—good, bad, and indifferent—can be measured and recorded, the more closely it would be possible to define the minimum limits of reasonably good daylight illumination for different classes of interiors.

The following particulars of the proportion of unrestricted outside illumination enjoyed by a few well-known buildings are only, of course, an example of what might be done if the subject were systematically taken in hand. The author would venture to suggest that if the investigation were taken up by a few illuminating engineers, standards of reasonable daylight illumination could readily be fixed for schools, libraries, hospitals, offices, workshops, factories, law courts, and all other classes of interiors.

The measurement of the daylight illumination of different buildings is also extremely interesting and instructive, and very quickly discloses to the investigator the strange prejudices by which the eye and the mind are frequently deceived.

* *Illuminating Engineer*, Vol. i., pp. 741, 811.

PROPORTION OF UNRESTRICTED OUTSIDE ILLUMINATION RECEIVED BY INTERIORS OF BUILDINGS.

New suburban elementary schools	children's desks	0·0025 to 0·008
New urban technical school	Class rooms, Ground Floor, average	0·001
	Upper Floors	0·002 to 0·004
Ordinary offices, centre of rooms, average		0·001
British Museum, Reading Room		0·007
,, ,, Entrance Hall		0·0017
Patent Office Library, centre of reading room		0·005
,, ,, ,, reading alcoves and galleries		0·0007 to 0·008
Royal Courts of Justice—Middle of Central Hall		0·0012
,, ,, ,, ,,	Courts—Judges' seats, ,, counsel, solicitors, jury and witnesses	0·0007 to 0·0022
House of Commons	Clerk's Table	0·0008
	Speaker's Chair	0·0009
	Behind do	0·0002
	Members' seats	0·0003 to 0·0007
House of Lords	Woolsack	0·0006
	Members' seats	0·0004 to 0·0006
	Commons Lobby	0·001
	Lords Lobby	0·0004
	Central Hall	0·0015
	Committee Rooms (Centre)	0·004 to 0·005
Westminster Hall (Centre)		0.0012
Charing Cross Station, Booking Hall		0 0001 to 0 0003
Surveyors' Institution, Centre of Library		0·0015

The Use of Coloured Glass to Simulate Sunlight.

THE depressing effect of continual dull weather is very generally admitted. It is, however, less certain to what exactly such depression is due. Probably the enforced restriction of outdoor life and the sombre appearance, even of the most beautiful scenery, under such conditions are not without influence.

But people indoors also seem to feel the depressing effect, and even when there is no direct outlook from the room in which they are sitting, the mere knowledge of the lack of sunlight without, conveyed by the nature of the light which filters through a skylight, is apt to have a subduing effect.

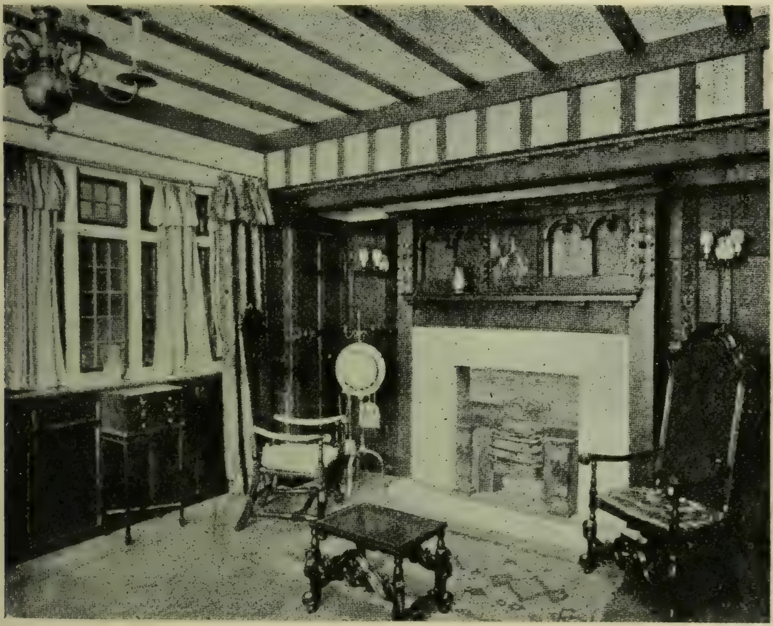
From this point of view the careful use of tinted glass in interiors (even it may be in conjunction with artificial light) in order to simulate sunlight, is an interesting possibility. There are a number of cases in which yellow glass of this kind has been employed, frequently in connexion with statuary. For instance, in the case of St. George's Chapel, at Windsor, the use of such yellow-tinted glass is very effective, throwing a flood of light upon the celebrated Canova sculptures; and it may be recalled how, in Napoleon's tomb in Paris the same means are adopted with the result that the central monument appears to be bathed in perpetual sunshine.

All such means of producing decorative effect do, of course, require careful handling, in order to avoid a descent from the sublime to the ridiculous. It is possible, however, that with the ever-increasing development in the facility with which artificial light can be produced and controlled, the use of such light to produce special decorative effects, may become much more general than at present.

The Use of Silk Shades in Artistic Interiors.

By an Engineering Correspondent.

The lighting of interiors having artistic pretentions cannot be determined on the same basis as might be, for instance, the illumination of an office. The artistic side of lighting is here predominant, and the sacrifice of a certain degree of efficiency seems often to be regarded as inevitable, in order to secure satisfactory æsthetic results.



One condition is almost instinctively felt to be of paramount importance, namely, the production of a "soft" quality of illumination—by which is usually meant merely the shading of all sources of undesirable brilliancy. In order to screen effectively in this way, coloured shades of silk and other material are very often employed; such materials not only tone down the brightness of the source but have also, when rightly employed, a certain artistic value in themselves.

In the oak-panelled room shown in the accompanying illustration it will be observed that the illuminants employed, which consist of artificial candles, are screened by this means. The principle involved in this imitation of candles in electric lighting has been commented upon before in this journa (see vol. ii., January, 1909, p. 41), and it is curious how frequently they seem to be adopted in artistic interiors. One would be inclined to look doubtfully upon such graftings of the old and the new, though it might, perhaps, sometimes be urged that in a room of a certain period it is essential to imitate the illuminants of the same period, namely, candles. In any case it is

probable that the central fixture in this room, judged as an efficient illuminating apparatus, would be criticized by many people, while objection on the same ground might be taken to the two groups of candles on either side of the fireplace.

The coloured shades, it will be observed, must obscure a very large percentage of the light which would otherwise be sent out into the room. If, as sometimes occurs, the sources are unscreened on the side facing the wall, the idea being to utilize indirect reflection therefrom, it is of course obvious that very little light could be derived by reflection from such a dark surface as that used in this case; yet, curiously enough, this system is often resorted to in cases in which the walls are dark in texture.

This case may, perhaps, be taken as typical of many in which, while the necessity of proper shading is realized, the efficiency of the fixture from an illuminating standpoint receives comparatively little consideration. It is often a difficult matter to compromise between the production of satisfactory illumination for practical purposes, and the satisfying of æsthetic considerations. One method by which this has sometimes been done successfully is the use of Holophane reflectors inside the silk shade; in this case sufficient light is sent out to illuminate the shade, and gives it a pleasing appearance, and the intrinsic brilliancy is as low as is desirable. But the great bulk of the light is reflected downwards, is usefully employed, and does not directly reach the eye.

The Sale of Light.

We notice in a recent number of our contemporary, *The Illuminating Engineer* of New York, a reference to several instances in the United States in which some regulation of the amount of light to be provided for a given expenditure, is definitely specified by the Supply Company and the Municipal authorities. It is stated that the policy already adopted by Hartford has been followed by the Central Station in Richmond, Ky.

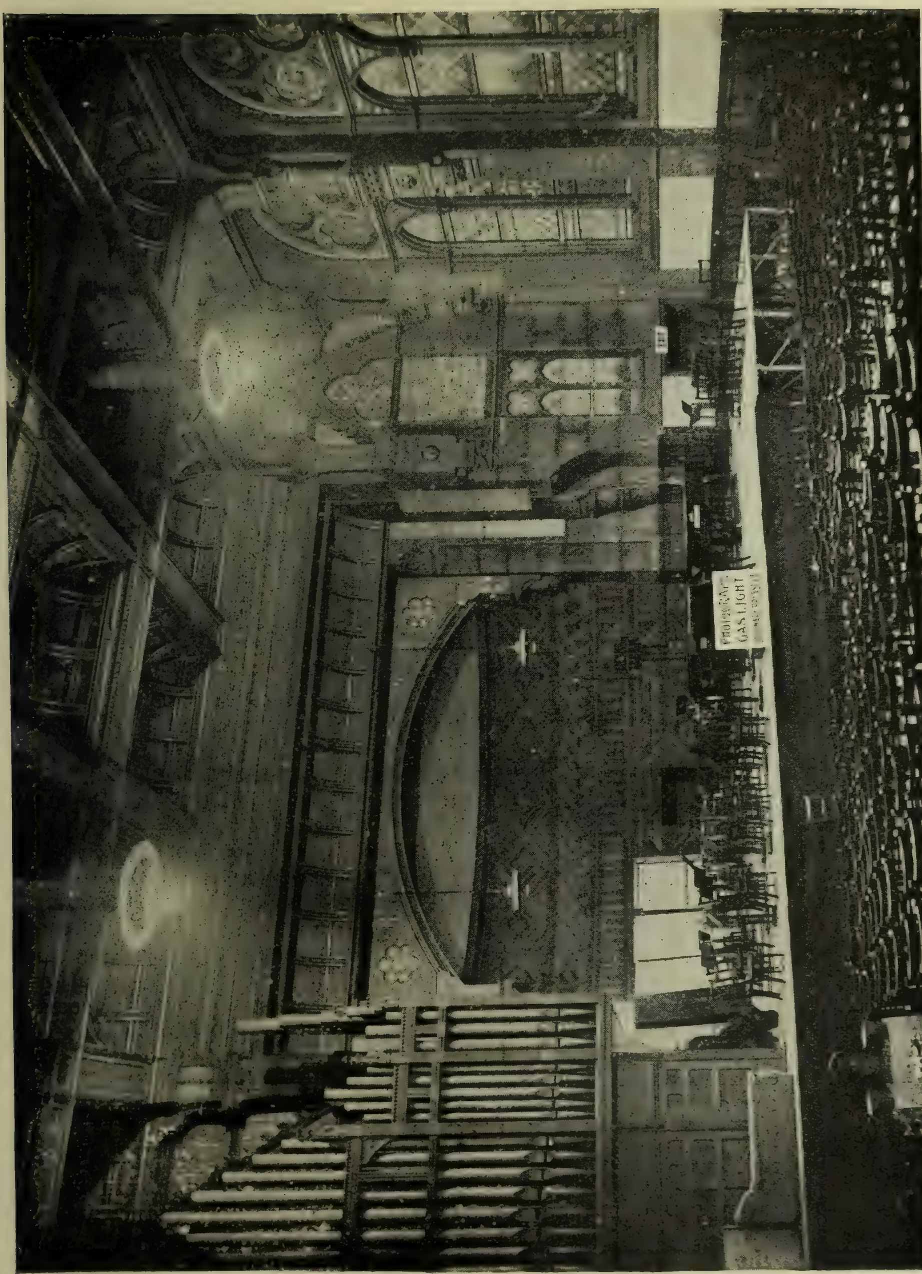
The exact provisions are stated to be as follows :—

"The purchaser of this franchise or privilege, or any successor, transferee, or assignee of such purchaser, shall not charge for electricity for any purpose a rate which will make the cost of electric light to any citizen of Richmond using more than $1 worth of electricity per month, with the most efficient incandescent lamps, more than 3½ cents per 100 candle-power per hour."

In commenting upon the matter, our contemporary remarks that, although this represents a distinct step towards definite contract to sell not gas or electricity, but *light* or rather *illumination*, the phrasing of the agreement is far from being sufficiently definite. The well-known controversy regarding the meaning of the term "2,000 candle-power arc" may be recalled as an instance of the confusion to which lack of precision in such matters may give rise, and it is pointed out that the word "candle-power" *in an unqualified sense*, should never be used as a basis for the sale of light; the word "lumen" or "spherical candle-power" should invariably be employed.

The Lighting of a Large Lecture Theatre by Gas.

The illustration on the opposite page represents the method of lighting the lecture theatre in the Midland Institute, Birmingham, having a seating accommodation of 1,000, by high candle-power gas lights. The total candle-power of the lights used is stated by Mr. G. H. Barber, the Secretary to the Birmingham Corporation Gas Department, to be 6,400; and the method adopted of placing them high up out of the range of sight must be regarded with approval.



The Midland Institute, Birmingham, Large Lecture Theatre, Lighted by Gas.

(For the use of this block we are indebted to the courtesy of the *Journal of Gaslighting*.)

The Design of Headlights for Vehicles.

The provision of lights on vehicles has been obligatory for many years, but the recent rapid development in the speed of traffic has rendered the scientific treatment to this matter particularly essential. Lights on vehicles serve a double purpose. They are intended to illuminate the road-way in the front of the vehicle so that the driver can ascertain what is coming and shape his course accordingly; but they are also intended to serve as an indication to people of the existence of the approaching vehicle, and both these points of view have therefore to be borne in mind.

The motorist, driving as he does at high speed, naturally feels the need of powerful headlights in order that he may detect any roughness in the road or obstruction some distance ahead, but, in increasing the intensity of these lights, we must remember that people in the street on whom the beam is directed may be bewildered by the glare.

Mr. Mervyn O'Gorman has recently pointed out in *The Times* Engineering Supplement (June 2nd) that it is in the interest of the motorist himself to design such lights so as to reduce this undesirable glare to a minimum. "It is generally admitted," he says, "that a person travelling down a road and meeting a powerful light will find that he can see nothing beyond it if the illumination intensity received by his retina exceeds a certain standard. It is not well known what that standard is; indeed, some measurements made on this subject were a revelation to the writer, and it must be borne in mind that no definition of glare is complete which does not take into consideration the available general illumination as well as the light from the lamp under test. Thus, if the most glaring headlights be lighted in the daytime they will not be found to be objectionable by any one—in fact they no longer glare at those points to the side of the main beam which might reasonably be occupied by a cyclist or carter. The ordinary conditions are those of twilight or moonlight, and accordingly a lamp may be said to glare or not to glare at a particular spot—say, to the eye of a man in the road ahead of it—according as some fairly dark object situated behind the lamp and to the side of it disappears or not from view when feebly illuminated, let us say, by a 1 candle-power lamp at a distance of 6 ft. It is remarkable that the standard of illumination which effectively reproduces glare to the onlooker under these conditions is represented by something less than half a candle-power at a distance of about 18 inches."

Various methods have been devised for reducing this glare; it has been proposed that a hand-operated black shutter should, at the discretion of the driver, be brought down between the burner and the mirror in order to cut off the powerful reflected beam without affecting the brightness of the direct light. Other methods employ lens or mirror systems which provide a moderate general illumination in conjunction with a localized beam restricted to a narrow area.

An additional point of some consequence to the motorist is the formation of a halo owing to the diffusion of light rays in the space surrounding the lens, especially in misty weather. This tends to prevent the driver seeing darker objects at a short distance ahead. Apart from the bearing on this point on the lens-design, it is interesting to note that a special type of mirrors has been devised which is intended to produce a beam with the maximum of intensity and the minimum of lateral diffusion. For instance, in one variety of reflectors recently devised a special electrically plated surface consisting of alternate rings of gold and silver coloration is employed with the object of reflecting the quality of light which, it is claimed, enables distant objects to be seen with the

maximum clearness, and yet to restrict sideways diffusion to as small an amount as possible. This quality appears to be based on the so-called "penetrating power" of yellowish light which is said to travel straight through the misty atmosphere with greater ease than light of white colour.

The whole subject has been considered of such importance that a special exhibition is to be held under the auspices of the Royal Automobile Club on Monday, July 19th, 1909, at the Crystal Palace ; if the club can succeed in specifying exactly how the required conditions of enabling the driver of a car to perceive surroundings, objects, and the road in front as he desires, and yet giving pedestrians and others notice of approach without bewildering them by excessive glare, can be met, they will have accomplished a very useful piece of work. In order to illustrate the importance which is now attached to the scientific design of such headlights, and the bearing on the problem of the principles of illumination, we reproduce, in what follows, the official announcement of this matter, which the Royal Automobile Club have kindly placed at our disposal :-

TESTS OF HEADLIGHTS FOR MOTOR CARS AND MOTOR CYCLES.

(*Under the Open Competition Rules of the Royal Automobile Club.*)

Object.

These Tests have been inaugurated by the Club to encourage the use of efficient headlights.

The Club has been investigating for some time the various causes which contribute to the unpopularity of motor cars among a certain section of the public. Amongst other contributory causes—all of which will be considered in due course—the popular outcry against the use of dazzling headlights carried on some motor cars and motor cycles has received attention. Those headlights now in use in many cases are a source of annoyance to other users of the highway on account of their dazzling effect.

The Club believes that this effect can be greatly minimized by the adoption of certain patterns of lamp which, while affording to the driver of a motor car or a motor cycle sufficient illumination of the road in front of him, have their beams so arranged or controlled that approaching pedestrians, bicyclists, and others are not dazzled by it.

The Club understands that many lamp manufacturers have already directed their attention to this important matter, and that some makers have produced lamps that are efficient in this respect ; and, while it is considered that the universal employment of back and front lamps on all vehicles would be the most effective way of reducing the demand for headlamps of high power, it is hoped that the proposed Tests will bring out the necessary points to be considered in the building of a successful lamp. In order to attain this end the Club has decided to conduct the Tests without requiring entry fees.

Supplementary Regulations.

1. Under the Rules and Regulations of the Club.—The Tests will be held under the Open Competition Rules of the R.A.C. for the time being in force, the General Regulations for Certified Trials, and these Regulations.

2. Date and Place.—The Tests will be held on Monday, 19th July, 1909, at the Crystal Palace.

If it becomes necessary to postpone the Tests on account of unfavourable weather it will be held on the succeeding night.

3. Entries.—Each entry must be made upon the official entry form of the Club, and the entry form shall state *inter alia* the name and address of the Entrant, who must be duly placed on the Competitors' Register. The entry form must be received by the Club not later than fifteen days before the advertized date of the Tests.

Only one lamp of each type may be entered.

A separate entry form must be filled up for each headlight submitted for test.

The last day of entry is Saturday, 3rd July, 1909.

The Club reserves the right to refuse any entry without giving any reason.

Entry forms and full particulars may be obtained from the Secretary of the Royal Automobile Club, 119, Piccadilly, London, W

4. Entrance Fee.—There will be no entrance fee.

5. Scope of Tests.—The Tests will consist of a practical trial of the dazzling effect and power of illumination of the headlights submitted. Each headlight is to be carried on a car, cycle, or other support of ample weight and stability capable of being moved from place to place and securely held in position on the road. It shall be placed at the

height selected by the entrant, and the beams shall be centred by him as may be directed by the Judges; the car, cycle, or other support being supplied and placed in position by the entrant.

6. CANDLE-POWER.—The illuminating power of the bare flame or bulb, apart from the intensifying effect of the reflectors or other arrangements, will be shown upon the Certificate. The candle-power will be found by an actual test of the lamp burners or bulbs. Two spare burners or bulbs must be submitted with each lamp a clear 14 days before the test. Each burner must bear an identification mark for each maker and lamp. In the case of electric bulbs the voltage at which it is to be operated shall be declared by the entrant and terminals shall be provided on the apparatus with which the lamp is to be supplied with current during the test at which the electrical pressure may be measured.

[Any form of lamp may be entered.]

7. POINTS OF MERIT.—The following points will be taken into consideration, and should be read in conjunction with Regulation 10:—

(*a*) Absence of dazzling effect.
(*b*) Range of the lamp.
(*c*) Horizontal dispersion of beam.
(*d*) Absence of back reflection.
(*e*) Simplicity of design and general construction.

8. SYSTEM OF MARKING.—The following is the scale according to which the various qualities will be considered:—

(*a*) 30 marks in relation to dazzling effect.
(*b*) 20 marks for range of lamp.
(*c*) 15 marks for horizontal dispersion of beam.
(*d*) 10 marks for absence of back reflection.
(*e*) 10 marks for simplicity of design and general construction.

No marks will be published.

9. CONDUCT OF TESTS.

(*a*) *Dazzling Effect.*—The lamp will be stationary on its car or stand. The Judges will approach it from a point in the centre of the road on which the competitor will have previously centred the lamp and will move diagonally through the beam to a point 6 ft. to the near side of the lamp. The eye-level will be taken as 4 ft. 6 in. above the ground. The distance at which the eye is not dazzled, *i.e.*, prevented from discerning an illuminated object two yards behind the lamp and two yards to the side of it will be taken as a measure of merit and may be recorded. The standard pattern or device will be marked on a screen of brown paper. The horizontal dispersion as measured in (*c*) taken at a height of 4 ft. 6 in. from the ground will also be measured and taken into account under this heading.

(*b*) *Range of Lamp.*—The distance at which the illuminating power of the lamp under test measured at 3 ft. above the road surface becomes equal to that of a standard lamp (this test will be made by photometer).

(*c*) *Horizontal Dispersion of Beam*, *i.e.*, the length of arc at a radius equal to half the distance ascertained under (*b*), and over which the illumination at the 3 ft. level is greater than the standard lamp used in (*b*).

(*d*) *Absence of Back Reflection*, *i.e.*, of stray light in a backward direction towards the driver.

10. CERTIFICATES.—The Club will issue a certificate of performance in relation to each lamp. The right is reserved to the Judges not to publish the numerical value in marks, in whole or in part.

11. SUPPLEMENTERY TESTS.—If considered necessary by the Club Supplementary Tests will be held. No fee will be required.

[Here follow some additional regulations regarding formalities of entry, damage, claims against Club, &c.]

17. INTERPRETATION OF REGULATIONS.—The interpretation of these Regulations and of any to be hereafter issued, shall rest entirely with the Club, which may at its discretion waive, alter, add to, or omit from, any or all of them from time to time.

If any dispute shall arise in connexion with these Regulations, or with any to be hereafter issued, or with the Test, the decision of the Club shall be final and binding, except in so far as is otherwise provided under the Open Competition Rules for the time being of the Club.

By Order of the Committee,
J. W. ORDE, *Secretary*

2nd December, 1908.

Modern Glow-Lamps and their Production.

By K. Sartori (Vienna).

Paper read at the Generalversammlung der Vereinigung oesterreichischer und ungarischer Elektricitätswerke; abbreviated.)

(*Continued from p.* 388.)

In a previous publication the author has explained how the nature of the energy spectrum of an incandescent illuminant, and its luminous efficiency, are dependent upon its temperature.* As a rule the maximum of such a curve lies far outside the visible range of radiation, and it is only at such an enormous temperature as that of the sun, estimated to be near 6,000°, that the maximum occurs in the luminous region. The eye, in fact, would seem to have adapted itself to this natural means of illumination, so as to use sunlight to the best advantage. The question has repeatedly been asked, "To what cause, exactly, do the metallic filament lamps owe their high efficiency?" and I have also participated in this discussion (*ref. cit.*). The whole question turns round the point, "Do metallic filament lamps radiate selectively or no?" I myself have finally come to the conclusion that the gain in efficiency can only be ascribed to selective radiation. Indeed, it may also be suggested that metallic filaments having, for a given input of energy, a larger surface area than carbon filaments, must attain only a lower temperature.

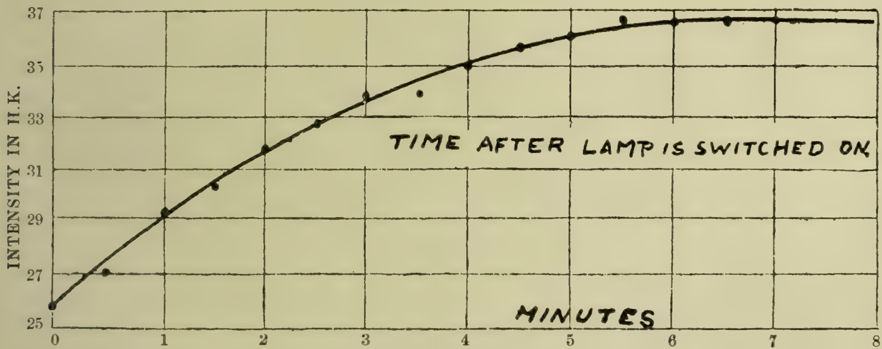


Fig. 5.—Rise in Candle-Power of Mercury-Carbon Glow-Lamp after being switched on.

It is probable that most of the later improvements in illuminants have been achieved through the use of selective radiation. The Nernst filament, was perhaps the last electrical example of a source of light the efficiency of which was mainly due to high temperature of incandescence. In passing it may be pointed out that most of the figures for this lamp refer to the intensity in the maximum direction; when *M. Sph. C. P.* is considered its consumption is probably not less than 3 watts per H.K.

As pointed out above the metallic filament has the merit of being less sensitive, as regards intensity, to a change in pressure. It might therefore be supposed that the metallic filament lamp was specially adapted for use on

* *Elektrot. u. Masch*, March 22, 1908. See also *Illuminating Engineer, Lond.*, Vol. I. p. 601.

unsteady circuits, such as would prove deleterious to carbon lamps. From one point of view this is certainly true, but it must also be recalled that the resistance of a metallic filament lamp, in the cold state, is *less* than when in a state of incandescence. This gives rise to a current greatly in excess of the normal values, which is, of course, injurious to the filament. For this reason metallic filament lamps are not adapted for use in cases in which they will be continually turned on and off at frequent intervals. They are, for instance, absolutely unsuitable for many illuminated signs on this principle.

Into the details of the manufacture of tungsten metallic filament lamps I cannot enter closely on this occasion.

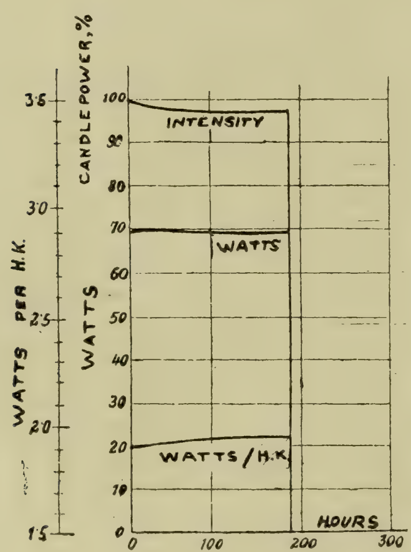


Fig. 6.

Life-Test on Mercury-Carbon Glow-Lamp.

Initial Intensity 36·1 H.K.
Initial sp. Consumption 1·92 Watts/H.K.
Life 189 hours.

The lamp was burned on a continuous D.D. of 110 volts, in a vertical position.

One such method, employed by Just & Hanaman, is the so-called "substitution process," according to which a carbon filament is brought to incandescence in an atmosphere of tungsten chloride and hydrogen. It is difficult to eradicate traces of carbon from the tungsten filament formed in this way, and this is probably the reason why the original Just lamp was unsatisfactory. I do not know whether this particular method has been abandoned or merely modified by the inventor in such a way as to remove all traces of carbon completely, but the Just lamp of to-day has certainly been very considerably improved.

Another method, due to Kuzel, is said to employ the finely divided gelatinous material formed by striking an arc between metallic electrodes under water. The filament, squirted from this material, is converted from the colloid into the crystalline condition by the passage of an electric current; how the filament is prevented from disintegrating in the process is not made clear in the patent.

The Westinghouse, and, I believe, the Watt Co., make use of a paste of tungsten material with some organic binding material, the organic constituent being subsequently removed by heating in a stream of hydrogen.

Among the many attempts that have been made to improve carbon filaments, perhaps one of the most original is that according to which such filaments are brought to incandescence in an atmosphere of mercury vapour. In order to obtain this condition a globule of mercury is enclosed in the bulb, and becomes vaporized very shortly after the filament is heated by the current. I have carried out some tests of a lamp of this kind, some results of which are shown in Fig. 5. It will be observed that the intensity of the lamp increases as a function of the time after it is switched on, before its condition becomes stationary owing to the complete evaporation of the mercury vapour. During the six minutes succeeding the switching on of the lamp the maximum candle-power is attained, the specific consumption falling from 2·5 to 1·9 watts per H.K. Unfortunately I have only had the opportunity of testing a single specimen of this type of lamp, but this yielded the short life of 190 hours.

Reference might also be made to the Helion lamp, of which news reaches us from America. This lamp utilizes a carbon filament on which silicon is

deposited; comparatively little, however, is known of the actual method of manufacturing these lamps. I myself have been able to carry out some experiments on one of them which was brought to a specific consumption of a ½ watt per candle. Under these conditions the lamp only lasted for five minutes, and for the following reason. Silicon forms a carbide better known as the hard and brittle substance carborandum, which is practically non-conducting. After a short time, therefore, the filament ceases to conduct owing to the formation of this substance. Nevertheless it appears to have been found in America by the inventors Parker and Clarke, that when the proportion of silicon is suitable a very efficient lamp can be obtained.

Among the many advances that have recently been made in methods of testing glow-lamps, attention may be drawn to processes for conveniently obtaining the mean spherical candle-power. The use of the Ulbricht globe in this connexion is well known, but this, of course only enables us to get the M.S.C.P., and not the polar curve of light distribution. Dr. W. Voege, however, has devised an apparatus utilizing a thermal couple, by the aid of which such curves are stated to be very easily obtainable, and the apparatus may be self-registering. Dr. Voege even proposes to utilize this apparatus in connexion with arc-lamps, though its application in this connexion is more open to question because the nature of the radiation from such lamps in different directions varies very considerably.

In Germany it has also been recently proposed to test glow-lamps by the method of rotation. I myself have made some experiments on this subject, but not with very satisfactory results. The method can hardly be applied to metallic filament lamps. One can, however, keep the glow-lamp itself fixed and rotate a suitable mirror around it. One might expect that the results so obtained would always be in agreement with those secured when the lamp is rotated, but this is not the case, differences as high as 7 per cent being recorded by some observers; this seems to be due to the distortion of the filament during rotation. I personally do not favour the use of mirror methods and do not make use of them in tests carried out in my laboratory.

Public Lighting of the City of Boston, U.S.A.

(Communicated.)

THE authorities of Boston have decided to light their city by electricity. The nature of the contract is reported in *The Illuminating Engineer* of New York, as follows :—

Mayor Hibbard has signed a provisional contract with the Edison Electric Illuminating Co. for lighting the streets for a period of five years. Under the terms of the contract the city will save $55,000 annually in electric street lighting over the contract with the same company which expired some months ago. Under the old contract the city paid $435,000 a year.

The contract which the Mayor signed provides, among other things, that the Mayor may call upon the Board of Arbitration consisting of the heads of the scientific departments of Harvard and the Institute of Technology and a third member selected by the scientific department heads of the two institutions to decide whether any changes in the contract price should be made.

Before signing the contract the Mayor made his acceptance provisional for six months to give the gas companies an opportunity of further demonstrating their scheme of street lighting and submitting other bids.

In view of the special efforts which have been made in this case to study the subject on a thoroughly scientific basis this decision is of exceptional interest. It will be remembered that several expert representatives of gas and electric illumination visited the Continent in order to observe for themselves the most recent advances in this subject and to report thereon. Certainly expert guidance in these matters is very essential, and it appears that the decision taken has been based mainly on authoritative photometrical

tests on the different illuminants considered. Previously the illumination of this city was carried out by means of series enclosed arc-lamps, each consuming about 500 watts and 6·7 amperes. After the investigation on the Continent, measures were taken to light up certain streets by magnetite and other arc lamps, and also by the newest systems of high pressure gas. Ultimately, as the result of tests carried out by Prof. Puffer of the Electrical Testing Laboratories, it was decided to adopt a form of magnetite arc consuming about 500 watts and 6·7 amperes and specially devised to meet the requirements of the case. The chief characteristics of these lamps are as follows :—

The upper electrode is short and thick and of copper ; the lower consists of a thin ½-inch iron tube packed with the magnetite composition, which has been of late considerably modified with the result that the efficiency of the lamp has been materially raised. The lower electrode is 9½ inches long and the globe of thin selected opal is long enough to accomodate it.

The lamp is also equipped with an enamelled reflector about 20 inches in diameter, and is credited with a consumption of about 0·35 watts per mean lower hemispherical candle-power. The distribution of the light is also said to be satisfactory, the maximum intensity being obtained at an angle of 20 to 25 degrees below the horizontal. These lamps will be substituted for the series enclosed carbon arcs to the number of 2,500 – 3,000, only a few hundred of the old type of lamps in outlying districts remaining.

The lamps are carried upon iron goose-necks forming the tops of hollow wooden poles, as the regulations in Boston do not allow using iron poles on high tension circuits. The normal height of the arcs is to be 25 feet above the pavements. It is proposed also to use, in large open places, very powerful flame arcs, of the type just being developed by the General Electrical Co. These arcs also work at 6·6 amperes, taking a little over 500 watts, so that they, like the new magnetite lamps, are worked in series with the regular enclosed arcs heretofore used ; thus the change from the old to the new will be accomplished, as the lights come in, without the slightest difficulty. These big flame arcs give a mean lower hemispherical candle-power of nearly 3,000, at slightly less than 0·2 watts per candle. They will only be used, however, in a few places, and at present only about one half dozen are in service. It is stated that they are exceedingly efficient for the lighting of squares, where they are placed at a height of 40 to 50 feet on brackets or pole-tops.

New lamps will, for the most part, be placed about 25 feet above the pavement, and it is stated that Boston will now be equipped with some of the most powerful illuminants ever used in America for street lighting.

The Law of Public Lighting.

A RATHER interesting legal point has arisen in a Scotch Court. A miner was crossing a street in Tranent between eight and nine on a Saturday night in September. The gas lamps in the street were not lighted. The man was knocked down and killed by a motor car. He could have seen the lamps of the car, but the people on the car could not see him. His widow sues the Provost, Magistrates, and Councillors of Tranent for causing the death of her husband by omitting to fulfil their duty. The defenders claimed the right to use a certain amount of discretion in carrying out their duties under their Police Act. "Not so," says the Judge, "there is no such modification implied in the Act. As soon as the sun ceases to give light you must provide it, and, if you do not, you are responsible for the results." As a matter of fact the action was dismissed, because the pursuer had not stated a full and relevant case. The deceased miner had a "duty of self-preservation," and the judge wanted an explanation of his failure to see the lamps of the car. That is in some ways a pity, for it seems that the responsibility of a lighting authority in such cases has yet to be established—in Scotland, at all events.—*The Electrical Times.*

REVIEWS, ABSTRACTS, AND REPRODUCTIONS.

Spacing Outlets and Selected Reflectors for General Illumination.

(Simple Rules Devised by the Holophane Company's Engineering Department for the Use of Practical Illuminating Engineers, and Published in the Bulletin to the Company for May, 1909.)

By general illumination is meant the illumination of a space considered as a whole; by local illumination is meant the independent illumination of certain portions of a space. General illumination may be uniform or non-uniform, but in the great majority of cases, such as large offices, stores, dance-halls, auditoriums, &c., it should be uniform.

After the correct intensity of illumination is determined (as explained in Bulletin No. 25), the problem of obtaining this intensity divides itself into two parts. First, determining the necessary wattage and second, dividing this Wattage among the correct number of outlets properly spaced with the lamps correctly equipped. The first of these consists of a simple calculation (see Bulletin No. 25). The second step is more difficult but is greatly simplified by an understanding of how the light is distributed by Holophane Reflectors.

General illumination is best accomplished by light-units distributed over the ceiling. By a light-unit is meant a single lamp and reflector or a group of lamps and reflectors on a chandelier. In the latter case the reflectors should all be pendant, should be hung at the same height and be of the same type. The chandelier can then be treated as a single light and the photometric curve, for all practical purposes, will be the same as the curve of a single light with the candle-power values increased approximately in proportion to the number of lights. In distributing the light-units over the ceiling, the area should be divided as nearly as possible into equal squares and a light-unit placed at the centre of each. It is important that the units be placed at the centres of the squares and not at the corners. Fig. 1 shows a common method of locating outlets. It is a poor method as it gives a low intensity of illumination near the walls as compared with the centre of the room. Fig. 2 shows the correct way to locate the same outlets.

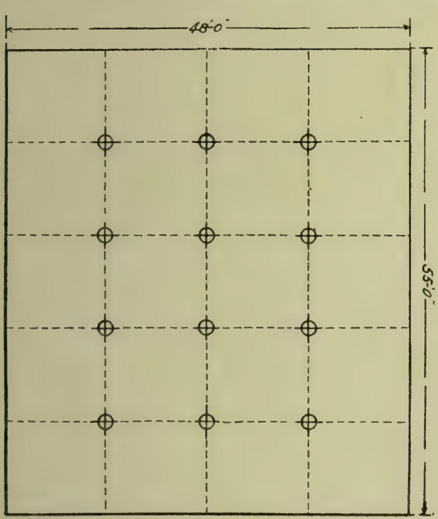


Fig. 1.—Poor Method of Locating Outlets.

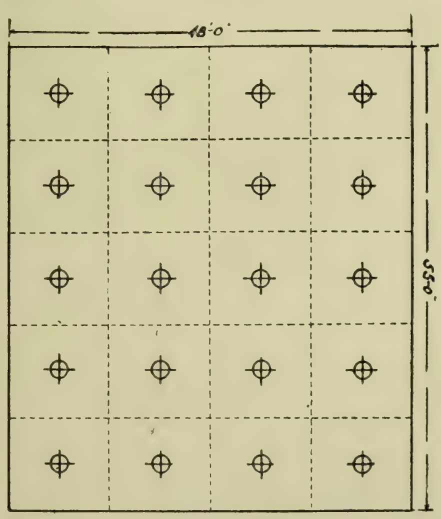


Fig. 2.—Correct Method of Locating Outlets.

The size of the squares depends upon the extent to which shadows of objects will be objectionable. For a given ceiling height, the smaller the squares, the less intense will be the shadows. In lighting large offices, where individual desk lights are not employed, the squares should be comparatively small in order to have the light on any one desk coming from many units, thus eliminating shadows and decreasing the glare due to regular reflections from the desk. In stores, the squares need not be so small. The following table gives the sizes of squares desirable for various spaces :—

Kind of Room.	Ceiling Height.	Desirable Length of Side of Square.
Armories, Auditorium, Public Halls, Rinks, &c.	12 to 16 ft.	12 to 16 ft.
	Over 16 ft.	15 to 26 ft.
Stores	8 to 11 ft.	8 to 11 ft.
,,	11 to 15 ft.	10 to 16 ft.
,,	Over 15 ft.	14 to 22 ft.
Offices with individual desk lights	10 to 20 ft.	12 to 18 ft.
Offices without individual desk lights	9 to 12 ft.	7 to 11 ft.
Offices without individual desk lights	12 to 16 ft.	9 to 14 ft.
Offices without individual desk lights	Over 16 ft.	11 to 18 ft.

NOTE :—The table cannot be strictly adhered to in all cases, and it is better not to use with the smallest ceiling height in each line, the largest size square available for that height. In office lighting with no desk lights, the squares should never be made so large that Extensive Reflectors are necessary to obtain uniform illumination.

The size of the squares bears no relation to the intensity of illumination, but only to the evenness of illumination and depth of shadow. After the size of the squares is determined, wattage, previously figured from the intensity desired, is divided among the outlets. If the wattage cannot be divided satisfactorily, the number of outlets must be changed by slightly changing the size of the squares.

The illumination within the space of any square, obtained directly from the light at its centre, will usually be high at the centre and will gradually drop off toward the sides to lower values, but the near-by light-units will raise the illumination near these sides so that uniform illumination results. Fig. 3 shows the illumination curve of a 100-watt tungsten lamp with Intensive Holophane Reflector at a height of 8 ft. above the plane of illumination. This plane is the imaginary surface on which the illumination is desired and is usually 2 ft. 6 in. above the floor. In this diagram, the height of the curve at any point has nothing to do with the height of the plane of illumination ; it simply represents graphically the intensity of the illumination in foot-candles at various distances from the light. The values are calculated only and do not include reflection from ceiling and walls. It is apparent at once that a single lamp with a Holophane Intensive Reflector should be used only when a higher illumination is desired underneath the lamp than at any other point. However, if another lamp and reflector is placed at the same height, 10 ft. away from the first one, the two illuminating curves will combine. The foot-candle intensity at any point is then the sum of the foot-candles at that point from both light-units. This is illustrated in Fig. 4. The dotted lines are the illumination curves of each reflector and the solid line is the curve of the illumination as actually obtained on the plane by the combination of the two reflectors spaced 10 ft. The total illumination is seen to be remarkably uniform. The Holophane Intensive Reflector is designed to give a photometric curve such that uniform illumination results when the units are placed at a height above the plane of four-fifths their distance apart. If the units were placed 10 ft. apart and less than 8 ft. high, the total illumination half-way between the units would be considerably less than the illumination directly underneath. If the units were placed 10 ft. apart and more than 8 ft. high, the illumination might be uniform and might not, but the intensity would be somewhat decreased as more light would be lost on the side walls. The constants used in the rule for obtaining the correct wattage for a space, apply only when the Holophane reflectors are correctly used.

If the wrong reflector—a Holophane Focusing type, for example — were used in the above case, the illumination directly under one unit would be much higher than the illumination half-way between. If the ceiling height permitted, however, focusing reflectors might be used. The rule for using Holophane Focusing Reflectors for general illumination is that the height shall be $1\frac{1}{3}$ times the distance apart, which in this case, where the outlets are 10 ft. apart, means that they must be hung at a height of 13 ft. 4 in. above the plane. Holophane Reflectors more concentrating than the Focusing, such as our Nos. 9651 and 9051, can be

used to give uniform illumination, but the height must be increased to at least twice the distance apart. For example, if the distance apart is 10 ft. as in the above case, the height of the Reflectors 9651 or 9051 above the plane of illumination should be 20 ft.

The spacing of outlets should be determined before selecting the proper

Place the Holophane Focusing Type Reflector at a height above the plane of illumination $1\frac{1}{3}$ times of the distance apart.

Place the Holophane Extensive Type Reflector at a height above the plane of illumination $\frac{1}{2}$ of the distance apart.

Place Holophane Reflectors having the extreme concentrating value (9651, 9051, &c.), at a height above the plane of illumination 2 times the distance apart.

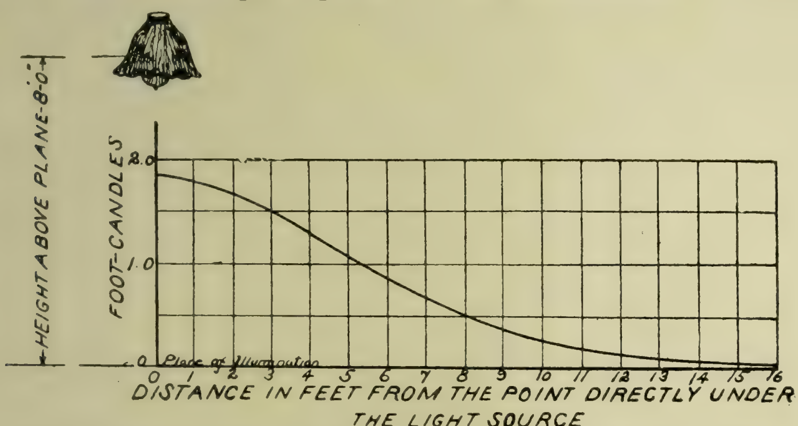


FIG. 3.—Illumination Curve of 100-Watt Tungsten Lamp with Intensive Reflector.

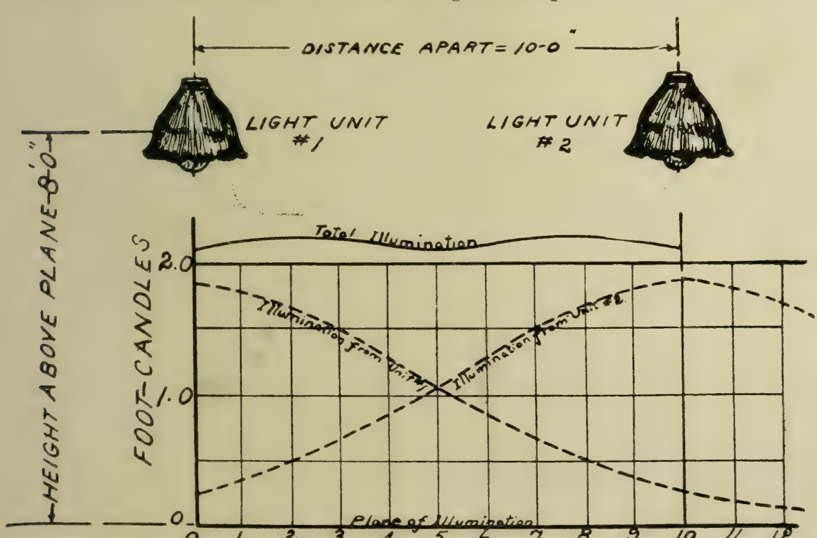


FIG. 4.—Illumination obtained from Two 100-Watt Tungsten Lamps with Intensive Reflectors.

Holophane Reflectors. The type of reflector selected should be one which will allow the units to be placed well above the range of vision and at a height correctly proportional to the spacing. The rules of height of the Holophane Reflectors for general illumination are, in brief, as follows :—

Place the Holophane Intensive Type Reflector at a height above the plane of illumination $\frac{4}{5}$ of the distance apart.

The Holophane Intensive and Focusing Reflectors are the most suitable for general illumination with a large number of units. Our Extensive Reflector should only be used where there is a single row of lights or where the ceilings are low or the outlets are already located too far apart for the Intensive Reflector. The extreme concentrators are suitable only for very high ceilings.

The Prices of Metallic Filament Lamps.

(From *The Electrical Times.*)

In commenting upon this matter, a recent number of *The Electrical Times* deprecates the tendency on the part of manufacturers to reduce prices too suddenly. It would be far better, it is urged, that manufacturers, "instead of expending misplaced energy in cutting one another's prices, would devote their efforts to improve the lamps themselves, it would be more to the interest of the trade and of the user. The tungsten lamp in its present forms is by no means ideal, and the actual price at which it is sold is quite of secondary importance compared with its efficiency, life and mechanical strength. If, by the united action of all the responsible factors and makers, the price were kept at a steady figure, giving a substantial margin of profit, manufacturers could keep abreast of their orders, and at the same time have funds available for adequate experiment and test operations, The perfect lamp, giving low candle power on high pressures, and so cheap to make that it can be sold at the price of a carbon lamp, will come in time, but its advent will only be hindered by forcing the pace and thus supplying a more or less satisfactory article simply to meet competition."

"With reference to the B.T.-H. lamps, this is one of the few types which are manufactured throughout in this country, and has only been placed on the market after careful and prolonged tests have convinced the makers that it is fully equal in life and efficiency to any tungsten lamp yet introduced. All B.T.-H. lamps are rated according to the British Parliamentary Standard. The high voltage Aegma lamp, giving a minimum of 25 Hefners (which are equivalent to 22 British candles), is now on the market and deliveries can be given at once. This is a 30 watt lamp, and marks the smallest unit of illumination yet reached by any maker of wire lamps to run singly on 200/260 volt supplies. The Sunbeam Co. lists a 22 candle-power tungsten lamp for high voltages, but deliveries of this type cannot be guaranteed until after July. Sunbeam lamps are made throughout at Gateshead, by British labour, and are rated in accordance with the British standard candle-power.

Several manufacturers are listing new types of wire lamps, some of which are of particular interest. The Edison and Swan Company, for instance, is putting forward its 'Metfil' lamp for single burning on any circuit up to 260 volts, and has come into line with the leading makers regarding price. Falk Stadelmann have also introduced a high voltage 'Efesca' lamp at 4*s.* 3*d.*, giving a minimum of 32 Hefner candles, and are listing other patterns of extra high illuminating power giving as much as 400 Hefners, at pressures between 100 and 260. G. M. Boddy and Company with the 'Metalik' and Simplex Conduits with the 'Simplex' lamp are now able to give deliveries of their improved low-candle-power high voltage patterns, which are listed as low as 4*s.* These lamps have bulbs short enough for use with ordinary shades, while the diameter allows of their adoption for flame, pine and other patterns of closed globes. The latter point is more important than it looks at first sight. In changing over a high-voltage installation from carbon to wire lamps, the hall and landing fittings and newel pillars could only be adapted for the new lights by altering the style of globe, and even then few closed globes have necks large enough to take them. In many cases, therefore, the carbon lamp has been allowed to remain. But now wire units as low as 22 British candle-power for 200–260 volts with small bulbs are available, and these can be used successfully to replace carbon lamps on any standard fitting. Among other new patterns of wire lamps should be mentioned the Osram and Sunbeam candle lamps for 25–50 volts listed by the General Electric and Sunbeam Companies, the Tantalum candle lamps of Siemens Bros. Dynamo works, and the tubular tungsten lamp of the Bryant Trading Syndicate and Mackey's Lamp Works, for reflectors of the Tubolite variety."

The journal also quotes the following list of existing prices, which, while not exhaustive, is stated to be fairly representative of the industry as a whole ;—

HOW PRICES STAND AT THE MOMENT.

Lamp.	Maker or Factor.	Voltage.	Min. C.P.	List Price.
Osram	General Electric Co.	25	10 (Hefnr.)	2/3
		100/130	16 ,,	2/9
		200/260	32 ,,	4/3
Tantalum	Siemens Bros. Dynamo Works	25	5 ,,	2/–
		50/130	12 ,,	2/–
		200/240	32 ,,	3/6
Simplex	Simplex Conduits			
Metalik	G. M. Boddy & Co.	25	5 ,,	2/3
Meta	Sloan Electrical Co.	60/130	16 ,,	2/9
Empire	Marsh, Son & Co.	200/260	32 ,,	4/–
E.M.F.	E.M.F. Manufacturing Co.			
Gral	Armorduct Manufacturing Co.	25	8 ,,	2/3
		100/130	16 ,,	2/9
		200/260	32 ,,	4/3
Aegma	Electrical Co.	25	6 ,,	2/6
		100/130	16 ,	2/9
		200/260	25 ,,	4/3
Z	Z Electric Manufacturing Co.	25	8 ,,	2/3
		100/130	16 ,,	2/9
		200/260	40 ,,	4/–
Auriga	British Westinghouse Co.	25	10 ,,	2/3
		100/135	16 ,,	2/9
		200/260	32 ,,	4/3
Sunbeam	Sunbeam Lamp Co.	25	8 (Brit.)	2/3
		100/135	14 ,,	2/9
		200/260	22 ,,	4/3
Efesca	Falk Stadelmann & Co.	100/130	16 (Hefnr.)	2/9
		200/260	32 ,,	4/3
Metfil	Edison & Swan Co.	25	8 (Brit.)	2/3
		100/130	25 ,,	3/–
		200/260	50 ,,	4/3
Tangent (Leuconium)	Gent & Co.	25	8 ,,	2/3
		100/130	16 ,,	2/9
		200/260	32 ,,	4/-
Stearn	Stearn Electric Lamp Co.	25	8 (Hefnr.)	2/3
		100/130	20 ,,	2/9
		200/260	32 ,,	4/3
Metalite	Bryant Trading Syndicate	25	6 ,,	*
		100/130	17 ,,	2/9
		200/260	32 ,,	4/3
Adnil (Bergmann)	Marples, Leach & Co.	25	6 ,,	*
		100/130	16 ,,	*
		200/260	32 ,,	*
B.T.-H.	British Thomson-Houston Co.	25	10 (Brit.)	2/3
		100/130	20 ,,	2/9
		200/260	32 ,,	4/3
Rugby	Rugby Lamp Co.	25	8 ,,	2/3
		100/130	20 ,,	3/–
		200/260	40 ,,	4/3
Gabriel	Gabriel Lamp Co.	25	8 (Hefnr.)	2/3
		100/130	16 ,,	2/9
		200/260	32 ,,	4/–
Solium	Calux Electric Co.	25	8 ,,	2/3
		100/130	16 ,,	2/9
		200/260	32 ,,	4/3
Omega	Omega Electric Lamp Co.	25	5 ,,	2/3
		100/130	16 ,,	2/9
		200/260	32 ,,	4/3

* Net prices not yet fixed.

CORRESPONDENCE.

Visual Acuity and Light of Different Colours.

DEAR SIR,—I have read Prof. L. Weber's communication in the last number of *The Illuminating Engineer* with interest.

Prof. Weber does not seem to express a definite opinion regarding the quality of light which he himself considers best from the standpoint of visual acuity.

I should like to make it clear, in commenting thereon, that in my article I have not suggested that the green end of the spectrum is invariably better for purposes of detail-revelation than the red end. In the case of very near vision it seems to be *somewhat* better, but (at least in my own experience) when we are concerned with distant vision the exact contrary seems to be true, the advantage of *red* light as compared with pure violet or blue being very marked. In my article it was sought to explain this mainly on the basis of the want of achromatism of the eye, but I quite realize that there may be other contributory causes, and, before asserting anything very definite, would like to see my somewhat approximate experiments carried out with a larger number of observers, and with more perfectly monochromatic light.

In my article I merely wished to suggest that visual acuity could not serve as a satisfactory basis of comparison of the luminous intensity of sources of different colour, as generally understood.

I may, however, say a few words with reference to the method of using red and green transparent screens in heterochromatic photometry, as advocated by Prof. Weber in his letter, and in his well-known and widely recognized paper of 1884.

The method, although so carefully worked out, seems to me open to possible objection on several scientific grounds. It seems quite reasonable to seek to establish a connexion between the integral brightness of a source, and the brightness in the red and green portions of the spectrum in the case of incandescent solids approaching the black body in nature, and emitting radiation which is subject to more or less clearly defined laws. Prof. Weber's results even suggest that the method may be sufficiently rigid for practical purposes in the case of such illuminants as the metallic filament lamps, the filaments of which are believed by many to exert marked selective radiation, though a special calibration seems to have been found desirable in each case. But it surely could not be applied to illuminants which yield a more or less discontinuous spectrum, such as, for example, the mercury vapour lamp containing practically no red element, and some varieties of flame arcs.

Again it seems to me undesirable, scientifically, to estimate the illuminating power of sources by reference to the red and green parts of the spectrum where the luminous intensity is so comparatively low. One would have been inclined to suppose that such a method as that of Crova, which is at least intended to utilize the part of the spectrum which is most effectual from the standpoint of illumination, was preferable, though this method has admittedly practical difficulties.

One would also have supposed that the super-imposing of a red or green glass screen in front of the field of view of a photometer illuminated with reasonable intensity, would cause the photometric surfaces to appear so dim

to the eye as to interfere with the accuracy of the instrument.

Finally it must always be remembered that all such methods only postpone the fundamental difficulties of colour photometry and in no wise avoid them. For, however simple such a method may be, it seems always to rely on a previous determination by an expert who attempts to compare the brightness of the two sources to be compared absolutely, and whose readings therefore must be subject to all the old physiological difficulties, and to some extent arbitrary in nature. It is here that general agreement on the principle on which heterochromatic sources should be compared seems to be wanted. It seems inevitable that any attempt to compare such sources should be to some extent arbitrary. But let us at least agree upon some common course of action. I am, yours truly,

J. S. Dow.

The Efficiency of High Pressure Gaslighting.

Dear Sir,—The comment upon my article published in the June number of your journal raises the question as to what method should be adopted of specifying the results of tests of candle-power of gaslamps, in order that the performances of different types may be strictly comparable one with another.

I find myself in complete agreement with the author when he states that to-day, both in Germany and in England, results are too often quoted without exact particulars being given, much confusion being thus caused. When tests on upright mantles are described one may, with some certainty, and in the absence of a definite statement on this point, assume that the figures quoted refer to horizontal intensity. But in the case of inverted burners it is always uncertain whether the maximum, the horizontal, or the mean hemispherical intensity is intended.

In the investigations of St. Claire Deville, and of Mayer and Schmidt, to which I have referred, the horizontal intensity was invariably measured. The mean spherical intensity does not deviate so greatly from the horizontal in the case of upright mantles, as in the case of the inverted lamp; according to Wedding it is 70 per cent in the case of the upright mantle. The M.Sph. Candle-Power of the inverted light, on the other hand, appears to be about 50 per cent of the maximum, and this in itself might go far to explain the discrepancies to which your correspondent refers. For instance, the efficiency referred to mean spherical intensity, as determined by St. Claire Deville, and Mayer and Schmidt, is about $37 \times 0{\cdot}7 = 26$ candles per cubic foot, while, according to the measurements of the Keith light by Herring, the mean spherical candle-power, on the above assumption, would be $60 \times 0{\cdot}5 = 30$ candles per cubic foot. The difference between these figures is about 10 per cent, and this, having regard to the probable difference in the nature of the gas burned in the two cases, is not much.

It will be observed, therefore, how important it is always to add the index to the symbol denoting the intensity, as was recommended by the International Photometrical Commission of Zurich, in 1907. These symbols should be as follows :—

I_h, Mean horizontal Intensity.

I_o, Mean Spherical Intensity.

$I_{\smile}$, Mean Lower Hemispherical Intensity.

Believe me, Yours truly,

Prof. H. Strache.

The Eyesight of Wireless Telegraph Operators and the Effect of Ultra-Violet Rays.

DEAR SIR,—Pray accept my excuses for not having replied before to your letter drawing my attention to the communication to *The Times* of Mr. Marconi. I was unfortunately extremely unwell at the time, and was unable to reply in time for publication in your June number.

I may say that I am entirely in agreement with the suggestion contained in the footnote which you have added to this letter of Mr. Marconi. It is evident that he, while contesting my conclusions, confirms the results of my observations regarding the necessity of protecting the eyes of workers from the effects of the spark, by enclosing the latter in an envelope opaque to ultra-violet rays.

With regard to the possibility of the other nervous troubles to which I have referred, it would, of course, be absurd to take seriously the suggestions of some people whom Mr. Marconi, with some reason, stigmatizes as insane, to the effect that wireless waves are responsible for wide-spread injury throughout the world in general. Such a theory has never received support from me. But—and this is a point which Mr. Marconi seems to have overlooked—it is unreasonable to draw a close parallel between the conditions prevalent in the case of an ordinary wireless station and those which prevail upon a battleship. In the latter case the apparatus is situated amid surroundings almost entirely composed of masses of metal; usually, indeed, it is specially protected by means of steel breastwork, just as it would have to be in war. On the land stations used in transatlantic telegraphy, on the other hand, there are available space and means to enable these defective conditions resulting from the presence of large quantities of metal to be avoided.

I am, it is true, disposed to believe that certain modifications in the nervous system of sailors on board the battleships of to-day are not due only to the direct effect of electric waves, but also to induced currents produced by the action of the electric spark in surrounding metal objects, and to the leakage and fluctuations of voltage which so often takes place on board ship. At the same time, though I have suggested that these observed neurasthenic effects may be explained on this principle, I have also taken the precaution to state that this is merely intended as a suggestion, and as a very debatable hypothesis. In the same way I might speak of other organic and functional troubles which, in my opinion, may be foreseen as a result of the effect of wireless telegraphy on board ship, but which our actual means of investigation may not at present enable us to detect.

In a word, Mr. Marconi does not seem to have taken into consideration the conditions to which my suggestions referred, and has needlessly occupied himself in defending an industrial enterprise which was never attacked. In my position as a physician in the navy, it is naturally my duty to study all the possible causes of injury to the health of those in my charge, and to devise practical means of avoiding them.—Believe me, yours sincerely,

DR. P. BELLILE.

(Médecin de 1re classe de la Marine, à bord du Descartes, Toulon).

The Extent of the Ultra-Violet in the Solar Spectrum.

(A. Miethe and E. Lehmann, Preuss. Akad. Wiss, Berlin, 8, pp. 268–277, 1909.)

THE author describes some experiments which were undertaken with the object of ascertaining the uttermost limit of the ultra-violet in the solar spectrum. Researches on this point have been carried out in the past by Cornu who appears to have been the first to recognize how greatly the results of such investigators depend upon the climatic conditions. In cloudy weather the extent of the spectrum is greatly reduced, and this seems to be largely due to the influence of water vapour. Cornu, indeed, was able to trace a distinct connexion between the extent of the ultra-violet spectrum and the barometric pressure. Minute particles of dust are also of influence, but it is thought that these do not very greatly effect the absorption of the very short rays which probably takes place in the highest regions of the atmosphere. It is also stated that ozone in the atmosphere introduces a marked absorption band intended from about 285 to 333 $\mu\mu$; Cornu seems to have fixed 292·2 $\mu\mu$ as the uttermost limit.

The authors have carried out a series of investigations in Egypt, Germany, and at Zermatt and other stations in Switzerland, choosing the highest altitude obtainable, and present a complete map of the lines detected in the ultra-violet. The ultimate limit of the short wave region recorded by them is 291 $\mu\mu$.

Some Publications recently Received. *

Das Beleuchtungswesen vom Mittelalter zur Mitte des XIX Jahrhunderts aus österreich-ungarn, by L. E. von Benesch (Verlag von Anton A. Schroll & Co., 17, Hegelgasse, Vienna, i. Price 42 mk.).To this unique and interesting volume we mean to make special reference in a future number. The author has compiled a most complete and valuable record of ancient forms of lamps and methods of illumination from the Middle Ages up to the middle of the nineteenth century. Apart from their great historical interest many of the designs reproduced are of considerable suggestive value from the artistic standpoint, and the comprehensive collection of choice illustrations, designed to illustrate the author's remarks, is an admirable feature of the volume.

Praktische Photometrie, by Dr. E. Liebenthal (Friedrich Vieweg & Sohn, Braunschweig, Germany). The well known comprehensive treatise of Dr. Liebenthal on photometry; readers are referred to the detailed review of the work in a previous number of *The Illuminating Engineer* (vol. i. Feb., p. 168).

Der Gasrohrleger und Gaseinrichter, by F. Kuckuk (R. Oldenbourg, Münich and Berlin, 1909).—A handbook for gas-fitters and others engaged in the gas industry.

Konstruktion Elektrischer Bogenlampen. By E. Bohnenstengel. (Ferdinand Enke, Stuttgart, Germany, 1909).—An up to date treatise on arc lamps; the book deals in special detail with regulating mechanisms of all kinds, and contains an exhaustive resumé of German patents on this subject.

Die Entwicklung der Leuchtgaserzeugung seit 1890. By Dr. W. Bertelsmann. (Ferdinand Enke, Stuttgart, Germany, 1907).—A historic summary of the progress of gas production since 1890; the book forms one of the series "Sammlung chemisch-technischer Vorträge," edited by Dr. F. B. Ahrens.

Éclairage und Chauffage au Gaz. By M. Roret. New edition edited by E. Bancelin, vols. i. and ii. (Enclycopedie-Roret, L. Mulo, Libraire-Editeur, 12, Rue Hautefeuille, Paris).—These two volumes consist of a practical treatise on gas lighting and heating, with the addition of a series of tables, and other information of interest to those engaged in the gas industry.

Entwurf und Einrichtung von Handelschiffen. By H. Herner. (Dr. Max Jänecke, Hannover, 1909).—This work forms the sixth of the series entitled "Grundriss des Maschinenbaues," and is a treatise on the design and equipment of merchant vessels.

* [To some of these publications we propose to refer in detail shortly.]

Betrieb elektr. Licht und Kraftanlagen. By H. Pohl. *Die Elektricität in der Landwirtschaft.* By W. Fuhrmann.—*Schutz der Hochspannungsanlagen.* By H. Zipp.—*Die Matierialen des Maschinenbaues.* By Prof. A. v. Lachemair.—The above works are additions to the "Bibliothek der gesamten Tecknik" series, issued by Dr. Max Jänecke, Hannover, Germany.

Repertoire des Industries Gas et Electrique, 1909 (Maurice Germain, Directeur, Redaction et Administration, 7, Rue Geffroy-Marie, Paris, Prix 3 fr.).—This volume is devoted to a summary of information relating to the gas and electric industries in France.

Unsere Beleuchtung in Vergangenheit und Gegenwart. By K. A. Kuhn. (Hermann Hillger, Verlag, Berlin).—A popular summary of past and present methods of illumination.

Private House Electric Lighting. By F. H. Taylor. (Percival, Marshall & Co., 26–29, Poppin's Court, Fleet Street, E.C., Price 1*s*.).

The Annual Report of the Medical Officer to the London County Council. (Messrs. P. S. King & Son, 2 and 4, Great Smith Street, Westminster). We have received from Dr. Kerr, Medical Officer to the London County Council, a copy of his report up to December 31st, 1908. We note that the report contains some interesting references to the subject of illumination in schools and its effect upon eyesight, and we propose to deal with some of these matters in detail in our next number.

Transactions of the Illuminating Engineering Society (New York). The transactions of the Illuminating Engineering Society for April is an unusually bulky publication, and, as usual, contains a selection of papers dealing with a wide range of subjects connected with illumination. Some reference is made to these in our Review of the Technical Press.

Proceedings of the Instituti.n of Civil Engineers (London). The proceedings of this society contain contributions of an original nature on a wide variety of subjects, including the address of the President, Mr. J. C. Inglis, and a long paper by Mr. D. A. Matheson on the Glasgow Central Station Extension. Other papers deal with Portland cement, preservation woik on bridges, the serviceable life of locomotives, and the Rotherhithe tunnel. In the volume containing the usual abstracts of papers in other scientific transactions and periodicals it is pleasant to observe not a few dealing with different aspects of lighting, including oil, gas, and electricity.

Among other publications we have to acknowledge the receipt of the *Proceedings of the American Academy of Arts and Sciences*, *Proceedings of the American Institution of Electrical Engineers*, the *Journal of the Society of Architects*, the *Institution of Electrical Engineers*, and the *Journal of the Royal Society of Arts*.

Metallic Filament Lamps.

Messrs. Ehrich & Graetz (Berlin), send us particulars of the "Graetz" metallic filament lamp which is stated to consume about 1 watt/H.K. to burn in any position, and to be exceptionally durable and able to withstand vibration in transport. We note that lamps for 100 to 130 volts of 16 up to 200 H.K. are manufactured with the "globe" shape of bulb. Lamps with a "pear" bulb are listed from 16 to 50 H.K. at the same voltage. It will be noted that the list price of 16 H.K. lamp is only 2·2 and 2 marks respectively, another instance of the prevalent reduction in prices.

The Electrical Co. (121-125, Charing Cross Road, London) send us particulars of the new Aegma lamp for 100-130 volt circuits. These lamps, we understand, are made to give 16 candle-power at the above voltage, at a consumption of 1·2 watts per British candle. They are also made with a special small size bulb, which enables the lamp to be installed with existing shades, &c. Sixteen candle-power 100 volt Aegma lamps are listed at 3*s*. each. It will be recalled that in our May number attention was called to a new form of Nernst lamp brought out by the same company.

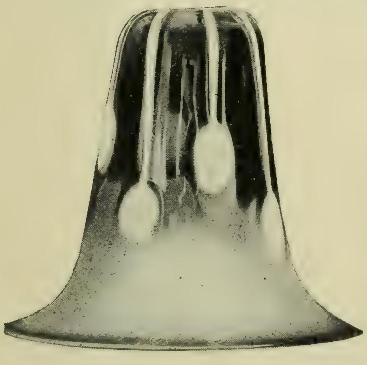
TRADE NOTES.

[At the request of many of our readers we are extending the space devoted to Trade Notes, and are open to receive for publication particulars of new developments in lamps, fixtures, and all kinds of apparatus connected with illumination.

The contents of these pages, in which is included information supplied by the makers, will, it is hoped, serve as a guide to recent commercial developments, and we welcome the receipt of all *bona fide* information relating thereto.]

Fixtures for Tantalum Lamps.

We have received from **Messrs. Siemens Brothers, Ltd.,** some lists of fittings specially intended for Tantalum lamps, including those of the "Majolica" type referred to in our May number (p. 350), in connection with ship lighting.



Particulars of Holophane and other glass fixtures are also to hand. These, it is stated, are intended specially for use with Tantalum lamps, and are of such a length that the end only of the lamp is visible, thus screening the filament and also showing off the tints of the shade to advantage.

This, of course, is an important point, as the whole success of artistic fittings may be prejudiced by anything in the nature of a glare, such as may easily be produced by the use of shades with a type of lamp for which they are obviously not intended.

Two examples of shades intended for tantalum lamps will be seen in the above illustrations.

Deposit Free Globes for Flame Arc Lamps.

We have received from **Messrs. the Union Electric Co., Ltd.,** Park Street, Southwark, London, S.E., some further particulars regarding the special deposit-free globe now utilized with the Excello lamps, and referred to in our May number (p. 349). Attention is drawn to the fact that, by a slight modification, this new globe can be fitted to Excello lamps burning with the old pattern. List No. 5009, of the same company gives full particulars to date regarding prices of Excello lamps and carbons, for direct and alternating currents.

We have also to acknowledge the receipt of List No. 1013, comprising the "Union" medium size direct current dynamos and motors ($\frac{1}{4}$ to 40 B.H.P.)

The "Diazed" Fuse.

Messrs. the Siemens Schuckert Werke (Berlin), send us some particulars of the "Diazed" form of cartridge safety fuse. This consists of two parts, the cartridge fuse and a screw head holding it in position. The change in colour of a small plate on the fuse-holder, observed through a transparent plate on the head, gives an indication of a fuse having burned out and enables it to be located at once. The form of the fuse is designed to avoid explosion and splashing of melted metal, and, since they are made in different sizes corresponding to the current, fuses for different circuits cannot be interchanged, and the danger of too thick a wire being used is avoided. These fuses are made for currents up to 25 ampere, and pressures up to 500 volts.

Fittings for Holophane Glass.

We have received from **Messrs. Julius Sax & Co., Ltd.** (90 and 100, Charing Cross Road, London, W.C.), the most recent list and particulars of fittings for holophane glassware issued by the firm, and reproduce on this and the opposite page a few examples which may be found of interest by our readers.

Fig. 1 represents the reflecting bowl fitting, such as will frequently be utilized in order to produce a strong, but well-diffused central light. A feature in this fitting to which special attention may be called is the use of substantial chains to support the bowl. This, of course, is necessary from a mechanical standpoint, and is a much more satisfactory method of support than reliance upon the conducting flexible wire.

Fig. 1.

Fig. 2 represents a bracket equipped with a small type holophane pine, which likewise exerts a diffusing action. The crystals in such pines are usually so shaped as to direct the great majority of the light downwards at an incline so that a bracket fitting of the type shown can be utilized in order to produce an adequate reading illumination for the benefit of any one seated beside the wall to which it is attached.

A second type of bracket is shown in Fig. 3. In this case the lamp is not completely enclosed, and is vertically upright instead of hanging. The type is thus of convenient application to the upright incandescent mantle. This type of reflector is specially adapted for wall brackets. The side of the glassware which is turned to the wall is grooved in such a way that only a small portion of the light striking it from the source is transmitted to the wallpaper. The greater part is reflected back into the room, passing, in doing so, through the diffusing crystal face of the glass which is turned away from the wall. In this way a small, but sufficient amount of light is allowed to fall on the walls, so that they do not appear unduly dark (which would be undesirable from a decorative standpoint). But the greater bulk of the light is diffused towards the centre of the room and in a downward direction, so as to be available where it is chiefly wanted, for reading and other purposes. These two fittings also have the merit of not relying on the flexible wire supplying current for support.

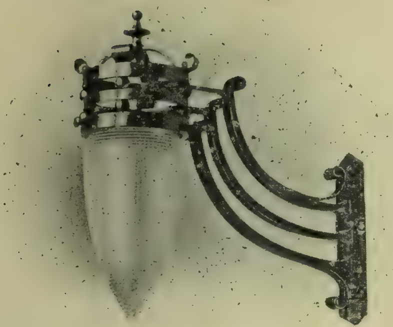


FIG. 2.

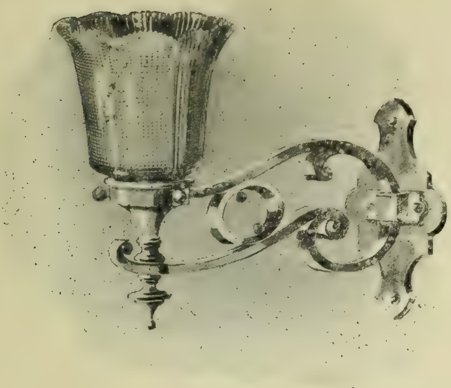


FIG. 3.

Portable Electrical Hand Lamps.

The adjacent illustration shows a type of hand lamp fed by current from a small portable electrical Edison Accumulator which is brought out by the **Deutsche Edison - Akkumulatoren Co.** (Drontheimerstr. Berlin).

The lamp can be carried about for a long time without recharging, and, it is stated, will supply a light of 2 candle-power for 5 hours continuously. The lamp is believed to be specially suitable for use in mines, on board ship, or in any cases in which danger of fire must be very carefully provided against. In addition the Edison battery used is stated to be exceedingly light and durable and to withstand exceptionally heavy discharge unusually well.

The Deutsche Laternen - Automaten-Fabrik (Ludwig, Ober-Elsass, Germany) send us a prospectus of their new form of apparatus for extinguishing or lighting gas lamps at a distance, by a change in gas pressure (Kilchmann system), for which great cheapness and reliability are claimed.

The "Anti Dazlo" Lens.

FIGS 1 and 2 on the opposite page refer to a new form of lens put upon the market by **Messrs. Henry Salsbury & Sons** (Long Acre, London), which is intended to reduce the glare—a troublesome feature of many motor-car lights—to a minimum.

If the rays from a powerful headlight are not controlled within a certain region they not only inconvenience any one who sees the motor-car approaching owing to the bewildering effect of the glare, but also render it difficult for a driver to see what is in front of him in a mist. For a large amount of lateral diffusion of light gives rise to a halo of light round the lens which makes it difficult to see dark objects beyond.

The invention consists in a built up type of lens in which reflecting and light absorbing surfaces are formed for substantially preventing upward projection of the rays of light from the lamp within the limit in which the intensity of the light would be, such as to produce glaring to an observer.

The lens is formed of a number of horizontally disposed strips of glass of special dimensions which are polished on their upper surfaces and finely ground on their lower surfaces; these are cemented together and the lens is optically ground and polished to any desired shape and mounted in a lamp. The burner is placed, for example, in the focus of the main reflector which projects the reflected light in a series of parallel rays through the prisms of the lens.

The rays of light which strike obliquely against the internal upper surfaces of the strips or prisms are reflected downward, while those which strike against the lower internal surfaces of the prisms are absorbed.

The general nature of the course of the rays will be understood from Fig. 1. In Fig. 2 is to be seen an illustration of the effect the lens is intended to produce, all the rays being concentrated below a certain level so as to illuminate the road instead of shining into the eyes of pedestrians or drivers of approaching vehicles.

Fig. 3 refers to another invention by the same firm, the "Dublito intensifier." The essential feature of this arrangement is that the actual source is hidden from view by a second small mirror in addition to the main reflecting one. This has the effect of reflecting the rays from the front of the source back so that they are once more reflected by the main mirror. There is thus no direct action from the flame, and in this way, it is claimed, a greater brilliancy is secured, and the dazzling effect is much reduced. This arrangement may be used in conjunction with the "Anti Dazlo" lens.

The Silverlined Shade and Reflector.

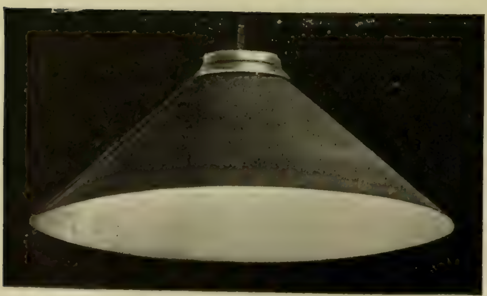


FIG. 1.

A form of opaque reflecting shade has been put on the market by the Silverlined Shade and Reflector Co. (4, Milk Street, Cheapside, E.C.), an example of which is shown in the accompanying illustration.

The Silver lining is deposited on a rough cloth surface on cardboard, and it is stated that the preparation for the surface is such that it can be easily cleaned, does not tarnish, and can be applied to any existing surface which it is desired to render reflecting. The cardboard shade is stiffened at the sides but still has the advantage of lightness and not being liable to breakage if dropped.

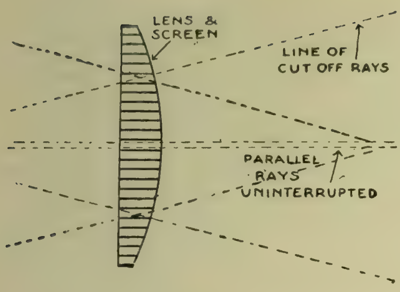


FIG. 1.
Illustrating the course of the rays through the "Anti Dazlo" Lens.

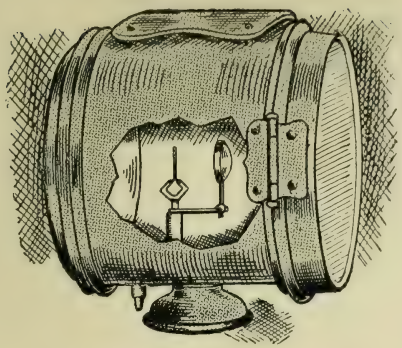


FIG. 3.
General appearance of Lens and Optical arrangements of "Dublito" intensifier.

FIG. 2.
Showing the arrangement of the beam, which is intended to be concentrated entirely below the eye-level so as to avoid dazzling effects.

Reduction in Prices of Tantalum Lamps.

We have received a new list from **Messrs. Siemens Brothers Dynamo Works Ltd.** (Tyssen Street, Dalston, London), dealing with the various types of "Tantalum" lamps now on the market, and announcing reduction in prices. The list illustrates "Tantalum" high voltage lamps, which are now to be sold at the reduced price of 3*s.* 6*d.* in bell-shaped bulbs, and 3*s.* 9*d.* in spherical bulbs. Further, standard bell-shaped or spherical "Tantalum" lamps of 50–80 volts, 12 and 16 candle-power, are now to be sold at 2*s.* each. The price sheet also shows illustrations of a new "Tantalum" candle lamp, which is supplied for 24–40 volt, and in 5 to 10 candle-power. It is anticipated that these lamps will find a ready acceptance generally for use with candelabra fittings, designs and prices of which, we are informed, can be had from Messrs. Siemens Brothers. We are also informed that the new factory at Dalston, opened some few months ago, has great facilities for the manufacture of these lamps, and that rapid progress in this direction has recently been made by the Company.

A New Form of Portable Photometer.

A new form of portable photometer has been brought out by Messrs. Siemens & Halske, equipped with ammeter and voltmeter and intended for the commercial testing of glow-lamps. The instrument is shown extended for use in Fig. 1, and folded in Fig. 2. It will be seen that the arrangement is entirely enclosed and a darkened room is therefore unnecessary.

The glow-lamp, the intensity of which it is desired to measure, is run in parallel with a standardized lamp of the same

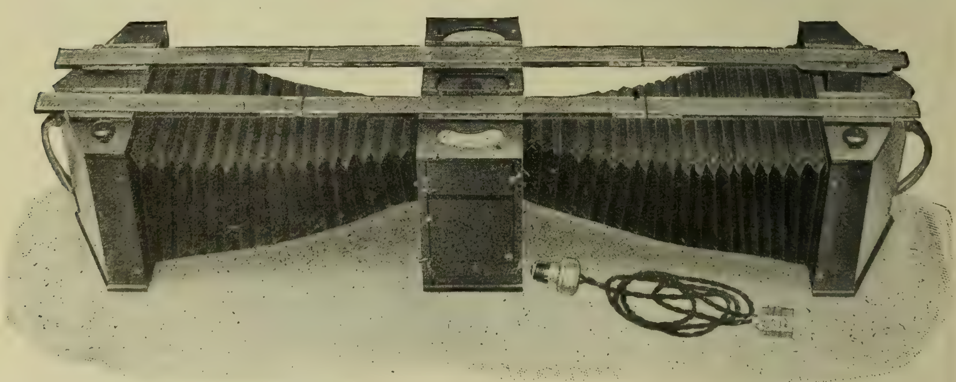


Fig. 1.

Fig. 2

variety, and therefore the results are not affected by small variations in the supply P.D. A 120 degree angle-mirror are placed behind each of the two lamps in the customary way. Candle-power can be read direct on the scale attached to the two lines on which the lamps move to and fro.

An interesting feature of the instrument is the use of a form of Bunsen screen formed by a silvered reflecting spot, placed between two frosted glass plates.

Review of the Technical Press.

ILLUMINATION.

A VERY large number of contributions falling under this heading have appeared, including the series of papers read at the annual meeting of the International Electric Light Association, and those published in the exceptionally bulky volume of the *Transactions* of the Illuminating Engineering Society (U.S.) for April.

Among the latter may be noted that by **J. R. Cravath** dealing once more with INDIRECT METHODS OF ILLUMINATION—a seemingly inexhaustible subject for discussion in the United States just now. The description of the LIGHTING OF *The New York World* OFFICES by **A. J. Marshall,** is chiefly interesting for the description of the method of combining mercury vapour and tungsten lamps together within a holophane globe giving rise, it is stated, to a variety of illumination which is quite satisfactory as regards colour.

A. A. Wohlauer gives some concise rules for CALCULATING ILLUMINATION. An article on a similar subject is that of **Whitney** (*Elec. World,* June 3), who gives a brief *résumé* of some newly introduced methods of calculating mean spherical candle-power. **C. Hering** deals with methods of obtaining the mean spherical candle-power of a source by taking the mean of selected values at certain specified angles. The paper by **Dr. E. P. Hyde** and others has already been dealt with in this journal.

A very large number of editorials are given up to illumination. Several such notices in the British papers deal with STREET LIGHTING, this discussion being aroused by the recent decision to adopt gas lighting in Bradford. It is objected in some quarters that the decision was taken without any adequate photometric data regarding the actual illumination in the road being presented. In this connexion reference may again be made to the recent decision of the Boston authorities which is also commented upon in several of the United States journals.

The Electrical World, as usual, deals editorially with several interesting topics. Thus some proposed legislation on RAILWAY HEADLIGHTS comes in for some criticism; recent tests seem to have shown that continual exposure of the eyes of servants of the railway company to the bright lights advocated may be prejudicial to the power of distinguishing colour. The subject of school lighting is also dealt with. Flame arclighting seems to be coming into more general use in the United States for public lighting. This method is being introduced in Copley Square in Boston, the lamps being arranged at the top of a high mast.

The Illuminating Engineer of New York, as usual, contains a number of readable articles, many of these dealing with street and public lighting, especially from the ornamental standpoint.

Dr. W. Voege (*E. T. Z.,* June 3), returns to the discussion of the EFFECTS OF ULTRA VIOLET LIGHT, armed with the results of fresh experiments. He again describes several additional tests designed to show that, for a given illumination, most artificial sources of light are not richer in ultra-violet light than daylight. The most important portion of his article is perhaps that giving the results of some tests on spectacle-glasses of various kinds designed to absorb ultraviolet light.

Lastly, reference may be made to an ingenious device due to **Guilloz** (*Comptes Rendus* 148, 1909, p. 164), intended to produce a patch of illumination which gradually changes in intensity according to any known law. This is accomplished by utilizing the image of a line source produced by a cylindrical lens, in front of which an opal shutter shaped according to the law which the illumination is desired to follow, is placed.

PHOTOMETRY.

Several communications dealing with photometrical subjects deserve a special section. Most of these deal with the recent announcement of the international candle; official communications from the Bureau of Standards in the United States, and the Laboratoire Central d'Electricité in France, corresponding with the announcement of the National Physical Laboratory, have now been published.

A communication from **Dr. Brodhun** (*E. T. Z.,* June 24) of the Reichsanstalt, also deals with the matter, and consists mainly of a comparison of the merits of the Hefner and Pentane lamps; practically, however, while dissociating themselves from any obligation to abandon the Hefner standard, the author and the German authorities recognize the numerical relations involved in the proposed

international unit. A paper by **Mr. C. C. Paterson** before the Physical Society (London) dealt with the same matter. The discussion in this case also turned mainly on the merits of different standards though it was pointed out that the announcement was merely concerned with the practical *unit* adopted. One of the most interesting contributions to the discussion was that of Dr. C. V. Drysdale who advocated the use of a black surface, maintained at a certain temperature, under certain specified conditions, as a primary standard of light.

ELECTRIC LIGHTING.

Few very novel contributions in the section of electric lighting seem to have appeared this month.

U. Bordoni, however. in the *Transactions* of the Italian Society of Electrical Engineers, publishes what is perhaps the fullest study of the mercury-carbon incandescent lamp that has appeared. He gives an account of the polar curve of distribution of light, the efficiency and life of the various samples studied; the life in this case seems to have been exceedingly low. The paper concludes with a discussion of the nature of the radiation from the filament and the phenomena which take place near to the glowing surface.

Several papers deal with the modified form of Küch lamp as recently described in the *Elektrotechnische Zeitschrift,* and referred to in a previous review.

O. Vogel continues his exhaustive treatise on the use of metallic vapours for electric lighting in the *Zeitschrift für Beleuchtungswesen,* and particulars of a new form of flame arc lamp, having double carbons, the "Flamgold," are published in *Electrical Engineering.*

A paper by E. E. Hoadley, covering more or less familiar ground (reported, *Electrician*, June 25), discusses the effect of the tungsten lamp on the electrical industry. Notices of new advances by various firms, such as the introduction of 16 candle-power 110 volt metallic filament lamps, appear in several journals. In this connexion special mention may be made of the complete *résumé* of the present situation as regards present prices, &c., in *The Electrical Times* (June 10 and 17).

GAS, OIL, ACETYLENE, &c.

One of the chief events of importance during the past month in this department has been the Annual Meeting of the Institution of Gas Engineers. The only paper read on this occasion dealing with matters directly connected with illumination was that by **Mr. C. Foreshaw,** containing a description of experiments on the Illuminating Powers of Carbon monoxide and Hydrogen, used in conjunction with the incandescent mantle. The experiment was designed to determine whether the incandescent illuminating powers of these two gases were in proportion to their calorific values. This was found not to be the case, other factors such as shape of flame entering into the problem. One point of interest studied in connexion with the paper was the effect of hollow cones placed within the mantle, which, it is stated, can increase the efficiency perceptibly.

The above paper is of special interest at the present moment in view of the discussion that is in progress regarding the possible complete substitution of calorific tests in place of tests of illuminating power as at present prescribed. **Mr. T. Holgate** contributes an article to *The Gas World* dealing with this point, and it is also the subject of an editorial in the same paper (June 12th).

The report of the Institution of Gas Engineers also contains an important note on the subject of the attempt that is being made to standardize methods of testing gas in all parts of Great Britain by a single type of burner.

Among other papers that have appeared mention may be made of that by **N. Macbeth** in the April number of *The Transactions* of the Illuminating Engineering Society (New York). The paper contains some tables of efficiencies of various sources. and several important points were raised in the discussion. It was felt that further data regarding the manner in which the candle-power of mantles varied with life was needed. Mr. P. S. Millar and Mr. V. R. Lansingh referred to the need for a satisfactory standardization of incandescent mantles in the same manner as is done for carbon filament incandescent lamps.

The same author has presented a paper explaining "Why the Gasman should be an Illuminating Engineer," which gave rise to much discussion.

E. Schilling (*J.f.G.*, June 19th) makes some pertinent remarks on the treatment of the general public, recommending what is practically advice to the consumer on illuminating engineering lines. It is pointed out, for instance, how much can be done by selecting and distributing the lights so as to fit the conditions in various rooms, so that the consumer uses all his sources to the best advantage, wasting no light, and being, therefore, satisfied that he is properly looked after.

Several communications deal with distance gaslighting, which continues to be

a topic of absorbing interest; modifications of existing systems are being constantly brought out. The *Zeitschrift für Beleuchtungswesen* as usual contains some particulars of new inventions relating to details of burners, &c.

An interesting short note is contributed by **Bruno** regarding the action of the small PERCENTAGE OF CERIUM OXIDE IN THE MANTLE (*Z.f.B.*, May 30th). The author discusses the reason for the falling off of candle-power during life of a mantle; this is closely connected with the amount of cerium originally present. A reduction in candle-power takes place exactly as if due to the loss of this active material. The author, however, claims to have demonstrated that the active cerium constituent is not lost by volatilization as is sometimes supposed. He developes a theory that a certain amount of the cerium oxide enters into solid solution in the thorium as the life proceeds, thereby becoming inactive.

Among contributions on acetylene matters special mention may be made of the reference to the LIGHTING OF THE GREAT AMERICAN RIVERS FOR NAVIGATION, in *The Acetylene Journal* for June. It had been suggested that on many such rivers the existing oil-lamps, should be replaced by automatic acetylene apparatus. It appears, however, that the uncertain behaviour of many of these rivers, and the constant overflowing and shifting of their courses, renders a permanent and expensive installation too risky; the present picturesque methods of strings of hand-fed oil lamps will therefore be retained. Some particulars are, however, given of the application of acetylene to some large breakwaters now in course of preparation.

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Byers, L. W. Public Lighting in Atlantic City (*Illum. Eng.*, N.Y., June).
Codman, J. S. The Simplification of Illumination Problems through the Conception of Light-flux (*T.I.E.S.*, April).
Coles, J. W. Street and Park Lighting (*Elec. World*, N.Y., June 10).
Cravath, J. R. Some Notes and Tests on Indirect Illumination (*T.I.E.S.*, April).
Editorials. Lamp Renewals. Lighting Copley Square (*Elec. Rev.*, N.Y., May 27).
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Retailing Light (*Gas Engineer's Mag.*, June 15).
Street Lighting (*Elec. Engineer*, June 4; *Electrician*, June 4).
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Eshleman, C. L. The City Beautiful (*Illum. Eng.*, N.Y., June).
Fradelle. Ornamental Curb Line Lighting (*Elec. Rev.*, N.Y., June 5).
Gibbs, L. Store Window and Sign-Lighting (*T.I.E.S.*, April).
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Jones, W. Basset. The Mathematical Theory of Finite Surface Light Sources (*T. I. E. S.*, April).
Marshall, A. J. Illuminating the Editorial Offices of the *New York World* (*T. I. E. S.*, April).
Massard, E. L'Éclairage des Rues de Paris (*Rev. des Eclairages*, June 15).
Pudor, H. Construktives des Beleuchtungskörper (*Z. f. B.*, April 30).
Spillmann, A. J. The Illumination of Hammerstein's Philadelphia Opera House (*T. I. E. S.*, April).
Voege, W. Ueber den Schutz des Auges gegen der ultraviolette Strahlen unserer kunstlichen Lichtquellen (*E. T. Z.*, June 3).
Whitney. Elementary Illumination Calculations (*Elec. World*, N.Y., June 3).
Wohlauer, A. Calculation and Design of Illumination (*T. I. E. S.*, April).
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Some Hints on Illuminating Engineering (*The Electrical Field*, June).
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Streetlighting Tests at Bradford (*Electrician*, June 4; *Elec. Engineer*, June 4, 11; *Elec. Engineering*, June 3, 10, 17).

PHOTOMETRY.

Editorials. International Agreement on Photometrical Units (*Elec. World*, N.Y., May 27).
Candles and Confusion (*Elec. Industries*, May 26).
Brodhun, E. Hefnerlampe und Zehnkerziger-Pentanlampe (*E. T. Z.*, June 24).
Dettmar, E. G. Betrifft Internationale Lichteinheit (Note from German Committee of the International Electrotechnical Congress, *E. T. Z.*, June 24).
Janet, P. Note relative à l'Unification des Unites Lumineuses (*l'Electricien*, June 5).
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Wissmann, W. Lichstärke der Bogenlampen und die Bogenlichtnormalien (*J. f. G.*, May 29).

ELECTRIC LIGHTING.

Bordoni, U. Ricerche sopra le nuove lampada elletriche ad incandescenza Tipo Hopfelt (*Atti della Assoc. Elettrotecnica Italiana*, March-April).
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Appeal against Revocation of Arclamp Patents (*Elec. Engineering*, May 27).
16 candle-power 110 volt Osram Lamps (*Elec. Engineering*, June 3).
The Latest Form of Quartz Mercury Vapour Lamps (*Elec. Rev.*, June 18).
The " Flamgold " Double Carbon Flame Arc (*Elec. Engineering*, June 17).
The Present Prices of Metallic Filament Lamps (*Elec. Times*, June 10, 17).
The Development of the Tungsten Lamp (*The Electrical Field*, June).
The Meeting of the National Electric Light Association (*Elec. World*. N.Y., June 10 ; *Elec. Rev.*, N.Y., June 1).

GAS, OIL, ACETYLENE LIGHTING, &c.

Bruno, E. Einiges über Ceroxyd (*Z. f. B.*, May 30).
Editorials. Relation between Illuminating and Calorific Power (*G. W.*, June 12).
Foreshaw, C. The Illuminating Efficiencies of Carbon Monoxide and Hydrogen, used in conjunction with the Incandescent Mantle (*J. G. L.*, June 22 ; *G. W.*, June 19).
Holgate, T. The Classification of Town Gas (*G. W.*, June 22).
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Klebert, E. Lichtfeuer und Nebelsignale (*J. f. G.*, May 29, concluded).
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Report of the Council of the Institution of the Gas Engineers (*J. G. L.*, June 1).
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The Société Technique du Gaz and Distance-Kindlers (*G.W.* June 5).
Gasbeleuchtung von Eisenbahnwagen (*J. f. G.*, June 5).
Eine neue Gefahr für die Gasindustrie (*J. f. G.*, June 5).
Anhange-Vorrichtungen für die Glühkorper ; Regulierdüsen für Gaslühlicht (*Z.f.B.*, June 10).

MISCELLANEOUS.

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Fery, E. The Selective Radiation of Black Bodies acting as Receivers of Radiation (*Comptes Rendus* 148, pp. 77, 780).
Reiff, H. J. Elektrische Methoden zur Vakuummessung (*Elek. Anz.*, May 30).

CONTRACTIONS USED.

E. T. Z.—*Elektrotechnische Zeitschrift.*
Elek. Anz.—*Elektrotechnischer Anzeiger.*
G. W.—*Gas World.*
Illum. Eng., N.Y.—*Illuminating Engineer of New York.*
J. G. L.—*Journal of Gaslighting.*
J. f. G.—*Journal für Gasbeleuchtung und Wasserversorgung.*
Prog. Age.—*Progressive Age.*
Phys. Rev.—*Physical Review.*
T. I. E. S.—Transactions of the Illuminating Engineering Society.
Z. f. B.—*Zeitschrift für Beleuchtungswesen.*

REVIEWS OF BOOKS.

Electrical Illuminating Engineering.

By W. E. Barrows,

Professor of Electrical Engineering at the Armour Institute of Technology, U.S.A.

(*The McGraw Publishing Co.*, 239, *West* 39*th Street, New York.*)

The matter in this book, we are informed, originated in the notes compiled by the author for use in connexion with lectures at the Armour Institute. Prof. Barrows, is responsible for the organization of a course in illuminating engineering at this Institute, and has recently delivered a paper before the Illuminating Engineering Society dealing with instruction in this important subject.

The first chapter, devoted to light and colour, contains several useful tables on such matters as intrinsic brilliancy, absorption of globes, and reflecting powers of various surfaces. A short account is also given of the effect of different illuminants on various coloured surfaces and of the application of the principles involved to interior lighting.

Chap. ii. defines the chief photometric units, and a few other terms of common use in connexion with illumination.

Chap iii. deals with photometers and photometry. In the space available the author is naturally compelled to deal with this wide subject very summarily. The chief portion of the chapter is concerned with an account of various forms of illumination photometers, including the Weber, Bechstein, Sharp and Millar, and other types. Chap. iv. is given up to spherical photometry; the author explains Prof. Kenelly's process of evaluating the mean spherical candle-power from the Rousseau curve, and gives some account of the Globe photometer. In this and the preceding chapter we note a few misprints of names, such as "Ulbrich" for Ulbricht, and "Beckstein" for Bechstein, which require correction. Chap. v. deals briefly with light standards.

Chaps. vi. to ix. deal with the various electrical illuminants in an up-to-date manner, and are well illustrated, and Chap. x. with shades and reflectors special attention being paid to the latest Holophane patterns; the remaining chapter is devoted to illumination calculations, and is perhaps one of the most serviceable in the book.

Within the two hundred odd pages at his disposal Prof. Barrows has dealt with this wide field in a concise manner, and his book should prove of value to those wishing to gain a rapid survey of the subject. A commendable feature is the presence of a number of complete tables. The book would, however, probably be rendered still more useful if, in a future edition, the author were to include references to the more important papers dealing with the various topics treated. This would be of service to those who had already secured a general knowledge in directing their attention to sources where more detailed information might be available.

PATENT LIST.

COMPLETE SPECIFICATIONS ACCEPTED OR OPEN TO PUBLIC INSPECTION.

I.—ELECTRIC LIGHTING.

10,891/08. Filaments for incandescent lamps (C. S.) I.C. Oct. 7, 1907, Germany. Accepted May 26, 1908. Wolfram Lampen Alst.-Ges., 7, Southampton Buildings, London.

11,106. Portable lamps. May 22, 1908. Accepted May 19, 1909. H. F. Joel, 74, Windsor Road, Forest Gate, London.

11,539. Reflectors (C.S.) May 27, 1908. Accepted June 3, 1909. O. A. Mygatt, 322, High Holborn, London.

11,758. Lighting of roundabouts, &c. May 30, 1908. Accepted June 3, 1909. H. M. Darrah and L. A. Hackett, 55, Market Street, Manchester.

12,398. Metal filament lamp installations. June 9, 1908. Accepted June 9, 1909. W. Dierman, 18, Southampton Buildings, London.

12,656. Arc lamps (C.S.) I.C. July 8, 1907, Germany. Accepted June 16, 1909. D. Timar and C. von Dreger, 7, Southampton Buildings, London.

12,720. Manufacture of lamp filaments (C.S.) I.C. July 13, 1907, France. Accepted June 16, 1909. Soc. Française d'Incandescence par le Gaz (Système Auer), 24, Southampton Buildings, London.

15,116. Arc lamps. July 16, 1908. Accepted May 19, 1909. L. Shaw, Clun House, Surrey Street, London.

18,233. System of fitting incandescent lamps (C.S.) I.C. Jan., 10, 1908, France. Accepted May 26, 1909. G. Weissmann, 20, High Holborn, London.

19,365. Holders, sockets, &c., for lamps. Sept. 15, 1908. Accepted May 19. 1909. F. W. Bayliss, 18, Southampton Buildings, London.

25,044. Metal filament lamp (C.S.) I.C. May 14, 1908, Germany. Accepted June 9, 1909. H. Kuzel, 322, High Holborn, London.

27,144. Production of pure thin filaments of any length (C.S.) I.C. Dec. 13, 1907, Germany, Accepted May 26, 1909. A. Kroll and B. Saklatwalla, 322, High Holborn, London.

1,332/09. Metal filaments (C.S.) I.C. Feb. 22, 1908, Germany. Accepted May 19, 1909. H. Kuzel, 322, High Holborn, London.

5,567. Candle lamps (C.S.) March 8, 1909. Accepted June 9, 1909. C. C. Regnart, 29, Ansen Road, Cricklewood, London.

7,073. Lamps (C.S.) I.C. June 1, 1908, France. E. Frénot, 9, Warwick Court, Gray's Inn, London.

9,265. Metal filament lamps (C.S.) I.C. Feb. 18, 1909, Germany. Accepted June 9, 1909. Bergmann Elektricitäts Werke Akt. Ges., 31, Bedford Street, Strand, London.

11,149. Supports for lamp filaments (C.S.) I.C. July 13, 1907, France. Accepted June 16, 1909. Soc. Française d'Incandescence par le Gaz (Système Auer), 24, Southampton Buildings, London.

II.—GAS LIGHTING.

4,652/08. Inverted incandescent burners. Post-dated Aug. 26, 1908. Accepted June 9, 1909. G. H. Barber and S. R. Barrett, 18, Southampton Buildings, London.

10,688. Inverted incandescent lamps (C.S.) May 16, 1908. Accepted May 26, 1909. Akt. Ges. Schæffer and Walcker, and W. Schultze, 231, Strand, London.

11,349. Inverted incandescent burners. May 25, 1908. Accepted May 26, 1909. W. B. Smith, 66, College Street, Chelsea, London.

11,635. Inverted incandescent burner. May 28, 1908. Accepted June 3, 1909. A. S. Francis, 77, Chancery Lane, London.

12,146. Incandescent lamps. June 4, 1908. Accepted May 26, 1909. A. C. Noad, 18, Louvaine Road, St. John's Hill, Clapham Junction, London.

14,470. Inverted incandescent lamp. July 8, 1908. Accepted June 9, 1909. W. Hottonsen., 21, Charterhouse Buildings, Aldersgate, London.

15,630. Illuminating apparatus for intermittent signs (C.S.) July 23, 1908. Accepted June 16, 1909. R. Ullrich, 7, Southampton Buildings, London.

18,172. Apparatus for lighting and extinguishing at given times (C.S.) Aug. 29, 1908. Accepted June 16, 1909. H. W. Harris, 55, Chancery Lane, London.

19,315. Automatic ignition apparatus (C.S.) I.C. Sept. 14, 1907, Switzerland. Accepted May 19, 1909. H. Ruppert, 6, Lord Street, Liverpool.

19,755. Suspension fittings for inverted burners. Sept. 21, 1908. Accepted June 16, 1909. D. Mitton, 3, Brown Street, Market Street, Manchester.

24,925. Lighting and extinguishing lamps at a distance (C.S.) Nov. 19, 1908. Accepted May 19, 1909. A. Grossmann, 173, Fleet Street, London.

11,371. Lighting and extinguishing from a distance (C.S.) I.C. May 14, 1908, Sweden. J. F. Nässén and A. E. T. Bergström, 65, Chancery Lane, London.

12,579. Inverted incandescence mantles (C.S.) I.C. May 29, 1908, Germany. Neue Kramerlicht G.m.b.H., 7, Southampton Buildings, London.

III.—MISCELLANEOUS.

(including lighting by unspecified means, and inventions of general applicability).

13,752/08. Incandescence vapour lamps. June 29, 1908. Accepted June 16, 1909. A. Kitson, Birkbeck Bank Chambers, London.

15,757. Hydrocarbon lamps (C.S.) July 24, 1908. Accepted May 19, 1909. H. A. Rice, 321, High Holborn, London.

22,401. Igniting apparatus for gas or oil lamps (C.S.) Oct., 22 1908. Accepted May 19, 1909. E. Bérnardy, Sunbridge Chambers, Bradford, Yorks.

28,162. Glass fronts for lamps (C.S.) Dec, 24, 1908. Accepted June 16, 1909. O. W. Horobin and E. Aron, 4, South Street, Finsbury, London.

5,473/09. Optical condensing systems for illuminating purposes (C.S.) I.C. April 27, 1908, Germany. Accepted June 16, 1909. C. Neiss, 29, Margaret Street, Regent Street, London.

11,040/09. Incandescent burners for gasified hydrocarbons (C.S.) I.C. May 19, 1908, France. J. B. V. L. Harlé, 7, Southampton Buildings, London.

EXPLANATORY NOTES.

(C.S.) Application accompanied by a Complete Specification.

(I.C.) Date applied for under the International Convention, being the date of application in the country mentioned.

(D.A.) Divided application : date applied for under Rule 13.

Accepted.—Date of advertisement of acceptance.

In the case of inventions communicated from abroad, the name of the communicator is given after that of the applicant.

Printed copies of accepted Specifications may be obtained at the Patent Office, price 8*d*.

Specifications filed under the International Convention may be inspected at the Patent Office at the expiration of twelve months from the date applied for, whether accepted or not, on payment of the prescribed fee of 1*s*.

N.B.—The titles are abbreviated. This list is not exhaustive, but comprises those Patents which appear to be most closely connected with illumination.

ELECTRICITY · ACETYLENE · OIL · GAS

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Edited by LEON GASTER

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EDITORIAL.

The Press and the Illuminating Engineering Society.

WE take this opportunity of expressing our appreciation of the cordial manner in which the announcement of the formation of the Illuminating Engineering Society in this country has been generally received in the wide variety of periodicals which have commented upon the subject.

It is, of course, gratifying to all supporters of the Society to meet with recognition of the genuine need for their efforts, and it may be said that any doubt that may have occurred to some in the past as to the possibility and beneficial effect of such a Society has been effectually dissipated now that its exact aims have been more fully understood. Once it is realized that the main object of the Society is merely to provide an impartial platform for discussion of problems connected with illumination, and not to confer professional status, the beneficial opportunities it affords to all parties interested in illumination must be conceded.

It has been specially pleasant to observe the sympathy with the movement expressed in papers devoted to the work of the medical profession. We have often pointed out that the basis of good illumination is mainly physiological, for it is through the eye, and through the eye alone, that we are able to take advantage of the light distributed on our surroundings. This being so, the advice of the medical profession must be felt to be very necessary in aiding us to utilize this light to the best advantage, and their co-operation with engineers is much to be desired.

It may truly be said, however, that the business of our Society is to reconcile the points of view of all those interested in certain specialized aspects of illumination, and it is doubtless the appreciation of the value of such a Society as a centre of information and discussion that has caused it to be so heartily welcomed in so many different quarters.

The Value of Science and Scientific Method.

On Thursday, July 8th, His Majesty the King laid the foundation stone of

the Imperial College of Science and Technology at South Kensington, and alluded in happy phrase to the value of science to the nation. The establishment of such a college as this, he pointed out, served to illustrate very clearly how the supreme importance of the higher scientific education had come to be appreciated in this country of recent years. Lord Crewe made a graceful reference to the fact that it was to His Majesty's father, the illustrious Prince Consort, that the movement largely owed its initiation; we hope that this fruit of the movement will prove of great benefit to the nation, and that the Imperial College of Science and Technology will do valuable and useful work in the future.

It is certainly true that the nation has come—has indeed been forced—to appreciate the value of scientific education much more fully than in the past, and we have met several manifestations lately of the growth of this spirit. We have alluded to the establishment of the Livesey Professorship at Leeds, and the benefit which it will doubtless confer on the Gas Industry. Only a few weeks ago, too, the Prince of Wales speaking at the opening of the International Congress of Applied Chemistry, referred to the value of scientific training and method, warning us that the rule of thumb was dead and the rule of science had taken its place.

All this, we feel, is applicable with peculiar force to Illuminating Engineering. We have constantly to deal with conditions where the rule of thumb has until recently held undisputed sway; it is only of late years that *precise scientific tests* have been fully recognized to be processes necessary to secure efficient practical conditions of illumination.

The Lighting of the Streets of the City of London.

We have before us the report of the Deputation, appointed by the Streets Committee to the Corporation of London, to visit and report upon the lighting of Continental cities. The report is one of considerable importance, and the information summarized therein should prove of value to those anxious to gain a rapid survey of this subject.

The action of the Corporation in appointing this deputation is a sign of the times—a satisfactory indication of the growing feeling that illumination is in itself a wide and important subject that demands thoughtful study. As an illustration, too, of the developing desire on the part of the general public to gain some acquaintance with the practical details of illumination the visit of the deputation is interesting, and it affords a welcome example of a keener and more discriminating interest on the part of municipalities in the lighting of the streets under their charge.

At the same time we cannot but feel that the visit of the Deputation might have been even more instructive, and their report more influential, had the members been accompanied by experts connected with the different systems of lighting, who are naturally in a better position to appreciate technical details. Some time ago we drew attention to the action of the authorities in the City of Boston who were called upon to deal with the same matter, and we reproduce in this number a letter from the Street Inspector in which the grounds for the decision of that city are summarized. But in the case of Boston, it will be remembered, the authorities arranged for representatives both of gas and electric lighting to visit the chief cities of this continent, in order to discover the most recent developments in the methods of illumination with which they were connected; the authorities subsequently considered the reports of these gentlemen in conjunction with additional photometrical tests, before coming to a decision.

The lighting of the streets of London has been the subject of so much controversy that it is particularly desirable that an investigation of this nature

should be backed by powerful expert advice and assistance, in order that it may carry the necessary weight and contain no decisions which can be called in question. This is the more to be desired because other lighting authorities are naturally inclined to base their scheme of illumination on the finding on a report of this nature.

We observe that surprise has been expressed in several quarters at the suggestion contained in the report that the lighting of the streets in this city should be accomplished by means of centrally hung high pressure incandescent gas lamps provided with lowering gear, though it is presumably not intended to suggest the universal application of such a method. Certainly it would be unwise, in the present state of our knowledge of street-lighting, to attempt any general system of lighting without very carefully considering the functions each street is called upon to perform. This is fully realized in Berlin, where the system of incandescent high pressure gaslighting in use seems to have impressed the deputation. The width of the street, the nature of the traffic passing down it, the type of curve of distribution of light from the lamps installed and their position in the street—all these are points which have to be considered in conjunction with one another, and a type of lamp that is admirable in one locality may not answer if installed under totally different circumstances elsewhere. It need hardly be said, however, that although Berlin has expended much care and expert knowledge on its lighting, it does not follow that the methods adopted there (where special conditions, in several respects, prevail) are necessarily the best elsewhere, and the extreme diversity in the methods of lighting adopted in the different cities visited by the deputation seems suggestive in this connexion.

We observe, however, that the report wisely does not propose any sudden radical changes, and recommends further experiments in the streets of London before any final decision is taken. Such experiments, as we have pointed out before, are apt to be inconclusive simply on account of the absence of any sufficiently authoritative expert and impartial tribunal by whom they can be undertaken. Researches on the lighting of streets in this city have been undertaken before and have led to various conclusions; these have usually been accepted with acclamation by the representatives of methods of lighting favoured thereby, and rejected by those to whom they were unfavourable. The report of Mr. A. A. Voysey, Electrical Engineer to the Streets Committee of the Corporation of the City of London, will be fresh in the minds of our readers, and it will be recalled that his conclusions were hardly in accordance with those of this deputation.

We may also refer to the letter from the Superintendent of Streets, dealing with the lighting of the streets of Boston, to be found elsewhere in this number. The city of Boston (also after inquiring into the lighting of Berlin) has decided on magnetite electric arc lamps in preference to high pressure incandescent gas, and the letter referred to mentions data and results of tests apparently inconsistent with those in the report of the London deputation. We mention these particulars merely to illustrate our conviction that the lighting of a great city is not a matter which can be decided only by what is sometimes imperfectly described as "a plain, common sense, business-like judgment, &c."; by this is usually meant reliance upon ocular demonstrations and personal impressions, rather than upon the views of experts who have really made a study of the matter and can substantiate their judgments by precise photometric tests.

It need hardly be said that our present methods of testing are not perfect, and probably much less satisfactory than they will be in a few years. But this is merely because,

until recently, their value was not properly appreciated, and there was no adequate opportunity for discussion such as might lead to their improvement, or to common agreement of alternative and additional methods of testing. In conclusion, it may be well to remind those who seem to regard any attempts to establish definite data as "abstruse, mathematical and physical processes" of only theoretical value, that in Berlin, where street lighting has been so carefully studied, such methods of gaining information have not been neglected. If successful results have been obtained in that city it is largely through the efforts of such experts as Dr. L. Bloch and Professor Drehschmidt, who have recently been engaged in a thorough discussion of the merits of the high pressure gas and electric arc lighting systems installed, and who have not disdained to support their conclusions by appeal to definite scientific methods of test.

The Efficiency of Incandescent Illuminants.

An abstract of an exceptionally interesting communication by Dr. W. Coblentz, published in a recent number of the Bureau of Standards, and dealing with the conditions favouring the high luminous efficiency on the part of metallic filaments, will be found in this number. Much discussion has turned on the question whether or no the high efficiency of metallic filaments is to be ascribed solely to a high temperature, or whether there is present some degree of selective radiation. Mr. K. Satori, for instance, has even been credited with the suggestion that the temperature of many metallic filaments may be lower than that of carbon filaments, and Dr. Hyde and others have recently contributed work on this subject, which suggests that most metallic filaments radiate selectively to some extent.

This is confirmed by Dr. Coblentz, who recognizes three distinct factors governing the luminous efficiency of the newer lamps. He makes the interesting statement that most metals are known to possess an exceptionally high reflecting power in the infra-red and a correspondingly low value in the ultra-violet. Consequently, in accordance with Kirchoff's law, such metals also emit visible and ultra-violet radiation with ease, but suppress the infra-red, where the great bulk of the energy of most incandescent illuminants seems to be located. An interesting and peculiar fact mentioned by the author is that the above quality appears to be closely connected with the electrical conductivity of a metal.

This matter furnishes a striking example of the important scientific basis underlying the performances of incandescent sources of light, and we may anticipate that great improvements will be made in the future when our information regarding such phenomena is more complete.

The Tax on Light in Germany.

We observe with some regret that, in spite of all the objections that have been raised by those connected with a very wide variety of interests, trades, and professions, the proposal embodying the tax on means of illumination proposed by the Finance Commission in Germany has passed the second reading in the Reichstag, and fear is now expressed that it may become law.

It may once again be pointed out that a tax on light—which we repeat is not a luxury but a necessity—would form a most undesirable precedent. Even as it is people are often far too much inclined to base comparisons of different illuminants solely on cost, and to cut down the illumination to the lowest possible value from mistaken motives of economy; anything that tends to increase the costliness of light must tend to accentuate this tendency. On these grounds alone we think it would be unfortunate if the suggested tax were adopted, and still trust that wiser counsel may prevail.

LEON GASTER.

Review of Contents of this Issue.

Mr. A. P. Trotter (p. 511) on this occasion deals with some of the useful adjuncts to a photometric bench. He describes AN ADJUSTABLE GLOW-LAMP HOLDER enabling the lamp to be conveniently centred over any particular point on the photometer bar. He also describes a convenient piece of RECORDING APPARATUS by which individual photometric readings are registered as dots on a movable drum; the mean value is subsequently determined graphically by drawing a line through these points. The author also deals with the question of SCREENING, pointing out that it is usually unnecessary to work in a room with perfectly black walls, &c.

Dr. L. Bloch (p. 516) describes a method of explaining fundamental photometric quantities and terms by drawing AN ANALOGY BETWEEN THE BEHAVIOUR OF A SOURCE OF LIGHT AND A SAND-BLAST depositing sand at a uniform rate on the surface on which it impinges. In this way the conceptions of "intensity," "flux of light," &c., can be derived, and the inverse square and cosine laws deduced.

AN IMPORTANT REPORT, issued by the deputation which was recently dispatched by the Streets Committee of the Corporation of London to study the LIGHTING OF CONTINENTAL CITIES, is dealt with on p. 526. The report contains a summary of data relating to the lighting of the various cities. While not advocating any sudden modifications in the existing lighting of the streets of London, the report also contains recommendations to the effect that the lighting should, wherever possible, be accomplished by inverted high pressure gas lighting, centrally hung, and provided with lowering gear. Further experiments are to be made before decision is taken.

Following the above report (p. 529) will be found a copy of a letter from the Superintendent of STREETS IN BOSTON, U.S.A., regarding the lighting of that city. It will be observed that a quite different conclusion is reached, the city in this case having decided to adopt electric lighting by magnetite arc lamps in preference to high pressure incandescent gas. This letter comments upon some tests recently undertaken on the "Grätzin" high pressure gas lamp.

Dr. M. Gaster (p. 520) continues his series of articles illustrating the close connexion between light and religious beliefs. In the present article the author turns from the question of the worship of light as a divinity to the actual adoption of LIGHT IN WORSHIP, and as a part and portion of religious ceremonial.

M. A. Blondel (p. 524) contributes a short note on the subject of THE INTERNATIONAL UNIT OF LIGHT. He points out that it is not enough to secure agreement as to its value. It is also essential to agree upon a common name and symbol; otherwise confusion is bound to occur. M. Blondel offers several suggestions as to names and symbols which, he thinks, might meet the case.

Mr. Thomas Holgate (p. 533) continues his article on HIGH DUTY GAS LIGHTING. He deals with the regulation of pressure and adjustment of the quantity of gas per hour taken by a burner, the distribution of light, and the most favourable conditions of working. In the latter portion of his article, he discusses the influence of flame-temperature on the efficiency of burners, illustrating his remarks by reference to the work of M. Sainte Claire Deville. Finally, he classifies the chief types of burners in use as regards facilities for promoting high flame-temperature.

A paper by **Mr. A. Forshaw** (p. 539), recently read at the Annual Meeting of the Gas Institute in London, describes a series of experiments comparing the INCANDESCENT ILLUMINATING EFFICIENCIES OF CARBON MONOXIDE AND

HYDROGEN. In the present section the author explains the hypotheses attributed to M. Sainte Claire Deville and others which he desires to test, and briefly describes his experimental apparatus.

Dr. W. Voege (p. 543) again deals with THE PROTECTION OF THE EYES FROM ULTRA-VIOLET LIGHT. He describes some additional experiments designed to show that, under ordinary practical conditions, artificial illuminants are no more injurious, in this respect, than daylight. However, he also points out the necessity for special protection of the eyes by suitable dark glasses when studying arc lights, &c., and describes some spectro-photographic tests of a series of different varieties of glass specially intended to absorb ultra-violet light.

The recently published report of **Dr. J. Kerr,** Medical Officer to the Education Department of the L.C.C., is the subject of comment on p. 547. The report describes some tests of the EYESIGHT OF SCHOOL-CHILDREN in London, about 60,000 of whom are stated to suffer from marked eye-troubles. Dr. Kerr also refers to the lighting of the schools visited by him, the examination of which, it is stated, forms part of the regular inspection routine. Some figures are given regarding the quality of lighting found in various schools visited. Special stress is laid upon the necessity of avoiding work calculated to strain the eyes of young children, such as fine stitching, &c. For this, it is remarked, the lighting available in schools is rarely adequate.

The Annual Meeting of the British Acetylene Association is commented upon on p. 549. An address was delivered by the President, **Mr. C. Hoddle**, in the course of which he described some EXPERIMENTS ON A PETROL-AIR GAS PLANT. On p. 561 will be found communications from **Mr. Williams**, **Mr. Cox** and **Mr. Glasscoe**, commenting upon this address and replying to some of the criticisms passed by Mr. Hoddle.

Among other articles mention may also be made of the short reference to SOME EXAMPLES OF GAS LIGHTING IN BIRMINGHAM (p. 531), and the description of the ELECTRIC LIGHTING OF THE PALACE OF ICE IN BERLIN, a large artificial skating rink recently opened in that city (p. 518). On p. 525 will be found a short note on an example of the PRIMITIVE METHOD OF LIGHTING by splinters of resinous wood.

Mr. W. H. Fulweiler's paper on THE THEORY OF FLAME AND INCANDESCENT MANTLE LUMINOSITY is continued on p. 553. The author, in the present section, discusses the structure and theory of the Bunsen and luminous flames, supporting his remarks by references to a large number of other works dealing with this subject. Following the above will be found an abstract of a valuable communication by **Dr. W. W. Coblentz**, regarding the basis of the LUMINOUS EFFICIENCY OF METALLIC FILAMENTS. The author describes some experiments designed to ascertain the part played by selective radiation in influencing the efficiency of incandescent filaments. One interesting quality of metals mentioned is that they appear to emit radiation in the visible and ultra-violet with ease but to suppress radiation in the infra-red. A connexion can also be established between the radiating properties of metals and their electrical conductivity.

A short note on p. 560 deals with the APPLICATION OF ACETYLENE LIGHTING TO THE ILLUMINATION OF WATERWAYS. The illumination of many of the great American rivers has hitherto been effected by means of hand-fed oil lamps, and it has been suggested that automatic acetylene apparatus should be installed. The uncertain behaviour of such rivers, however, and the frequent floods which occur renders the installation of permanent and expensive illuminating apparatus out of the question.

At the end of this number will be found the usual REVIEW OF THE TECHNICAL PRESS and the PATENT LIST.

TECHNICAL SECTION.

[*The Editor, while not soliciting contributions, is willing to consider the publication of original articles submitted to him, or letters intended for inclusion in the correspondence columns of 'The Illuminating Engineer.'*

The Editor does not necessarily identify himself with the opinions expressed by his contributors.]

Illumination, Its Distribution and Measurement.

By A. P. Trotter,

Electrical Adviser to the Board of Trade.

(*Continued from p.* 442.)

Adjustable Lamp Holder.—No less important than the scale is the provision for setting the movable lamp or the photometer head to the index which points to the graduations on the scale. Two plumb lines of fine wire are sometimes used, one about six inches in front of the bar, and another at about the same distance behind it. The lamp is brought into line with these and with the index. In the case of an electric glow lamp, it should be run at a dull red; it is then easy to see the plumb lines without being dazzled. It is customary to adjust the lamp holder carefully with its centre over the index, and to leave the lamps to accommodate themselves to the holder, merely taking care that they stand or hang vertically. In dealing with large numbers of lamps there is no time for accurate adjustment, nor would it be worth while.

But in investigating any particular lamp, or in setting a standard lamp for the adjustment of the working lamp, care should be taken to set it exactly over the index. When an electric glow lamp with a looped filament is used, the centre can only be estimated by the eye. When a simple U or hair pin filament is used it may be set with considerable accuracy by the following method, either with reference to the scale or to some part of the photometer head.

For such work it is desirable to avoid the uncertain contacts of a bayonet lamp holder. Wires should be soldered to the base, and the lamp should be firmly held in a collar or sleeve with a spring or screw. Two metal plates,

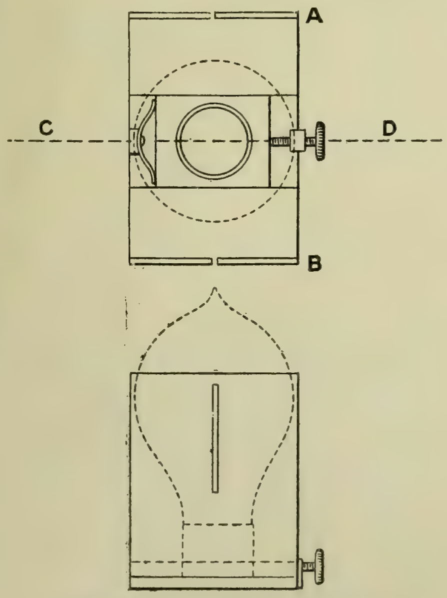

Fig. 83.—Adjustable Lampholder.

A B, Fig. 83, are rigidly fastened to the carriage, and the collar is attached to it by a slide allowing a little adjustment either way in the direction of the photometric axis C D. The plates have

vertical slots about one mm. wide through which, when the lamp is removed, a steel rule may be passed, and lie at right angles to the photometric axis. The steel rule being in position, a gauge rod is held against the photometric screen or against a stop constituting the central plane of the photometer head, or against a stop having a definite position with regard to the scale. The carriage is then clamped, and the gauge rod and steel rule are removed. The lamp is now put in place and is lighted. The slits allow beams of light to pass, and these are received on screens. The screens should be not less than about two feet distant on each side, and the screen nearer the observer should be of thin paper. By this means the filament of the lamp may be brought into exact coincidence with the plane passing through the slits. If the streaks of light on the screens and the lamp filament do not all lie in one line, the lamp must be adjusted until this is the case. If the streaks are double the filament does not lie in the transverse plane and the lamp must be turned until they are single. With this arrangement it is possible to use a very small working lamp placed close to the photometer.

Recording Instrument.—When an observer having no assistant is engaged in making repeated readings, say in sets of ten for averaging, much time can be saved by recording the settings graphically, instead of taking readings of the scale, writing these down, and taking the mean. An arrangement for making such records is shown in Fig. 84.

A roller A, covered with india-rubber, and provided with a ratchet wheel is mounted in a carriage which can be clamped to the bar. The axis of the roller is parallel to the photometric axis. Another roller B is pressed

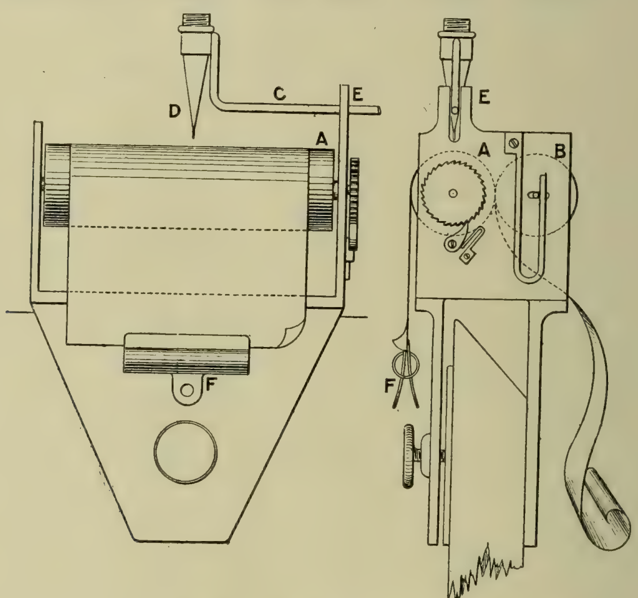

FIG. 84.—Recording Instrument.

against the first by springs, as in a type-writer. The length of the rollers depends on the kind of work to be done, in general a length of about three inches is convenient. A steel wire C is attached to the movable carriage of the photometer. This wire carries a needle or pencil or stylographic pen D, and is guided by the jaws E. The needle or pen is held near to but not touching the roller A, either by its own stiffness, or by a spring support on the carriage. A long strip of paper is passed up between the rollers, and hangs down over the roller A, and is loaded at the end with a paper clip F. Hanging free in this

way, the ink is given time to dry. A third roller is apt to cause blots, and hides the record.

The movable carriage of the photometer is set approximately at a balance, and the roller carriage is set so that the pen is approximately over the middle of the roller A. The roller carriage is then clamped to the bar. The index is set successively to the two larger divisions of the scale on each side of the approximate setting and the needle or pen is depressed, making two marks on the paper. The paper is pulled forward one step and the marks are repeated, together with marks corresponding to the intermediate divisions of the scale. The paper is pulled forward a step or two, and the photometer is adjusted. After each setting the pen is depressed and the paper pulled forward one step. At the end of a group of settings the scale marks are repeated. Fig. 85 is reproduced from an actual record. It represents the portion of the scale between 1·1 and 1·0, the mean is 1·07 and is the zero reading of the test of angle errors given on p. 440.

Such dots do not, of course, form an objective measurement as in an automatic recording instrument, they merely register the settings of the photometer, those settings being based on the judgment of the observer. The saving of time is very considerable. There is no need to turn up the light, or to use a mirror for seeing the scale, no need to read or write down or add up figures. A line may be ruled by eye through the dots to give the mean, and the best position of this line may be judged by holding a fine wire or hair over them.

This recording device may, of course, be elaborated by providing a key or lever which will depress the pen, and on rising feed the paper on one step. I find that needle pricks are inconveniently small, pencil dots are not uniform, and that the point section of a stylograph pen works very well.

Screens.—The traditions that the walls and ceiling of a photometer room should be painted dead black was shown to be a delusion by Mr. E. P. Hyde.* It is possible that such a dismal precaution might be useful in certain optical researches, but it is the wrong way to set about the prevention of errors due to stray light, and may be said to be a roast-pig way of securing a dark background.

Screens for photometric work may be divided into two classes, one for absorbing or stopping stray light from falling on the interior of the photometer head, and the other for preventing distraction of the observer's sight.

An absorbing screen, preferably of black velvet should be placed behind the lamp under test; a small one will suffice if other suitable stopping screens are used. Even black velvet reflects 0·4 per cent.† It is not essential that such an absorbing screen should be placed behind the working lamp. When this is set at a fixed distance from the photometer head it is sometimes convenient to make a small adjustment of its candle-power by placing a white or grey screen behind it.

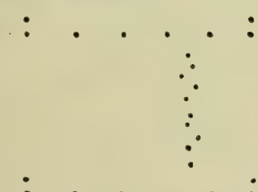

Fig. 85.—Record.

In general it is customary for both the lamp under test and the working lamp to be more or less enclosed in a box, unless the former is surrounded by mirrors or other arrangements for dealing with the whole light emitted. Some ventilation is necessary, and any kind of flame lamp must be thoroughly ventilated.

In electric lamp factories where several photometers are arranged in an open room, the whole of each bench is generally more or less boxed in. For arc lamp work a large partition shutting off part of the room is generally used, suitable openings being provided for working.

* Hyde, 'The Use of White Walls in a Photometric Laboratory, Bulletin of the Bureau of Standards, Washington,' Vol. No. 3, p. 417.

† Sumpner, *Proc. Phys. Soc.*, Vol. XII., 1893, p. 19; and *The Electrician*, Vol. XXX., p. 381.

If the observer could place his eye at the screen of the photometer he could form some opinion whether the light received there came from the lamp alone, or if any were reflected from other objects. With a Ritchie wedge photometer of the mirror type, or one provided with totally reflecting prisms as used by Dr. Drysdale, an inspection of this kind can be made by removing the translucent screen and looking into the photometer. With a perforated screen photometer there is a clear way through the axis, and either lamp can be examined through the hole. With other kinds of photometers a small mirror mounted on a handle in dentist's fashion may be held in the photometer head. But the light coming from the lamp is so blinding that faint stray light cannot be estimated. A small black screen so shaped and placed that it will just hide the lamp when viewed in this way, enables a useful inspection to be made.

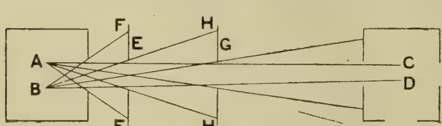

FIG. 86.—Screens.

When such small screens are placed in front of each lamp, either close to them or near the photometer head, any illumination of the photometer field is due to stray light.

Stray light may be of several kinds, it may be reflected from badly arranged screens, or from walls or ceiling, or from parts of the apparatus, outside or inside the photometer head, or, except in the case of photometers where the observer is obliged to look through a telescope, stray light may fall over his shoulder on to the photometer. The subject must be dealt with by common sense; the object is to avoid error. Mr. Hyde found in a room with white walls that with a suitable set of perforated screens on each side of a photometer, the other side being nearly surrounded by large screens, when a 32 candle-power lamp was used, the reflection from the walls was equivalent to 0·003 candle-power at the position of the 32 candle-power lamp, causing an "error" of one part in 10,000.

If any part of the apparatus is suspected of producing error by stray light, it is better to stop such light temporarily and try whether it has any appreciable effect on the photometer readings before going to any great trouble in altering the arrangements to get rid of it. It is quite unnecessary to try to make the room as dark as a photographic dark room.

Perforated screens or diaphragms should be arranged on the following principle. Let A B (Figs. 86 and 87) be the extremities of a lamp, and C D the extremities of the field of a photometer. Light from A B is to be allowed to fall on C D in such a manner that a full view of A B may be obtained from any part of C.D, but all other light from A B is to be stopped. The lamp A B is surrounded by an enclosure. In this a hole must

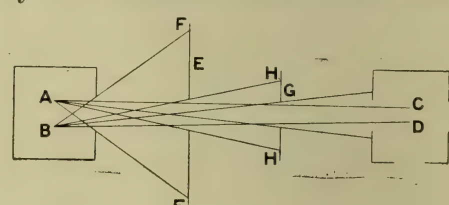

FIG. 87.

be cut, slightly larger than A B. Let E be the first screen. A penumbral cone of rays will fall on it, and the screen must be rather larger than its base F F. This screen must have a hole rather larger than enough to allow the rays A C and B D to pass. A penumbral cone of rays will fall on the second screen G, and this must be rather larger than its base H H. Finally, the light falls on the side of the photometer head and passes through a hole in it which should be rather larger than C D. If it is smaller than C D it will cast a penumbral shadow on it which is not agreeable. The screens should be crowded together towards the light in order to prevent excessive dimensions. In Fig. 86 a pair of similar screens are shown, properly placed. In Fig. 87 a pair of screens are placed uniformly. The screen nearer the light has to be very large.

It is easy to see whether the screens are large enough or are set close enough together to prevent light straying into the room, but it is not so easy to ensure that no part of the lamp is cut off by the holes. An inspection should always be made for this, either by direct view or by an inspecting mirror.

The problem may be regarded conversely. If A B is the photometer screen, then nothing but black screens can be seen from A B except through the opening in the box surrounding C D.

When many screens are used some provision must be made for the motion of the lamp or of the photometer head, or of the mirrors if the lamps and head are fixed. A lazy tongs set of levers is sometimes used for this purpose, but it is a rather clumsy arrangement.

Cylindrical screens are, in general, a mistake, diaphragms are always needed in addition, to cut off the light reflected from their surfaces. They are, however, useful in some kinds of experimental work. Dr. Paul Kruss* suggests that the photometer head should be provided on each side with a tube containing a number of blackened screens pierced with suitable apertures. This would perhaps be sufficient to prevent stray light from entering the photometer, but the observer would have to be shielded from the lights also.

Stray light falling on the translucent screen of a Rumford, Foucault, Gas Referee, Ritchie mirror, or Joly photometer will produce no actual error, but will tend to reduce the precision. With a Ritchie wedge, Conroy, or perforated screen photometer, a wide tube may be fixed in front of the photometer head, if it is to be used in a room in subdued daylight. High precision is not possible under such circumstances.

* *The Illuminating Engineer*, Vol. I., p. 381.

One further use of screens must be noticed. For good work, it is necessary that no stray light either through chinks in the enclosures of the lamps, or reflected from bits of bright metal work should reach the eye. It is also desirable that the whole field of view, except in the photometer field, if not quite dark, should be symmetrical. A dark curtain behind the photometer head is useful, and some workers prefer a curtain in front with a hole through which the photometer may be seen. This is used in the Gas Referees arrangement. It is not easily applicable to a moving photometer head.

It is worth while to take some care in arranging the screens, and stout card or thin board is perhaps better than velvet, since the position of the holes can be adjusted more exactly. It is generally convenient to hang them from a rail, and thus to keep the bar free for the moving carriage.

Dead Black Paints.—Such screens, and all visible parts of the photometer except the scale and the actual screens in the photometer, should be painted dead black. A common recipe for dead black varnish is a mixture of lamp black with shellac dissolved in alcohol. But if there is enough shellac to prevent the lamp black from rubbing off, the surface will generally be shiny. Varnishes sold by photographic dealers are seldom dead black. A good recipe is given in Spon's 'Workshop Recipes.' Mix lamp black and japanner's gold size into a paste, and continue to add lamp black until it is as stiff as putty; the less gold size the better. Then thin with turpentine. This holds well to metal. A good paint for wood or card may be made on the same principle by mixing lamp black with hot carpenter's glue, adding lamp black until the mixture (which should be kept hot) is very stiff. Then thin with hot water. It may be used hot or cold.

ERRATUM.—In Fig. 76, page 370, the angle marked 35 degrees should be *55 degrees*.

(*To be continued.*)

The Simple Explanation and Calculation of Fundamental Photometrical Terms.

By Dr. L. Bloch, Berlin.

Most people who have had occasion to explain the meaning of fundamental terms used in connexion with illumination either to those versed in the technicalities of the subject or members of the general public, must have been struck by the fact that much mental confusion on elementary points often seems to prevail. The ordinary consumer, for instance, very often confuses the candle-power of a lamp with the illumination produced by the aid of it. Even engineers not infrequently do not properly understand the meaning of such terms as "flux of light," "mean spherical" or "mean hemispherical candle-power," &c. Most engineers who have approached this subject with the desire to form for themselves clear conceptions of such elementary points will have felt the difficulty of framing lucid and simple explanations.

In my experience this is largely due to the lack of an actual concrete demonstration of what occurs in connexion with the distribution of light, and in my work entitled 'Grundzüge der Beleuchtungstechnik' (Berlin, 1902, T. Springer) I have followed up this idea and tried to utilize as illustrations processes which are themselves analogous and easily understandable. It has occurred to me, that a more detailed explanation of this system might be found of interest to readers of *The Illuminating Engineer*.

One may compare the radiation of light from a luminous source to the action of a sand-blast throwing out sand in different directions with different vigour. One can imagine further that the sand-blast exists in the middle of a large sphere, the inner surface of which is covered with some adhesive material so that the sand thrown upon it sticks. The influence of the gravitation may be ignored. The sand is thus projected in all directions vertically against the walls of the inner surface of the sphere and the thickness of the layer of sand deposited at any point depends upon the amount of it driven in that direction.

The two first fundamental photometrical terms which can be explained by the aid of this analogy are the *total output of light* from a source and the *light-flux*. The entire mass of sand projected on to the inner surface of the sphere in a given time corresponds to the entire output of light of a source. In practice, however, we invariably deal with the total output of light in a unit of time and call this the *light-flux*.

The total amount of sand deposited on all parts of the entire surface of the sphere in a unit of time corresponds to the flux ϕ_0, the total influx of light from a luminous source.

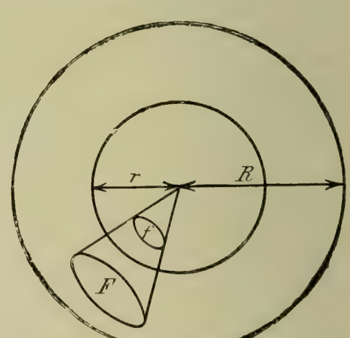

Fig. 1.

Consider now a portion of the surface of a sphere of radius R, represented by F in Fig. 1. In the same way the amount of sand deposited on this area F during a unit of time corresponds with the flux of light striking it. If a second sphere of smaller radius r be described round the point-source as centre, the solid

angle corresponding with the surface F will cut the surface of the smaller sphere, thus giving rise to the smaller sectional area f, and this area will be connected with F by the relation

$$\frac{f}{F}=\frac{r^2}{R^2}$$

Now since we suppose the sand to be directed only radially the amount of sand received on an area contained within a given solid angle will be always the same independent of the radius of the sphere, on the surface of which such an element of surface is taken. Thus in the above case, since the surface F is greater than f, the density of the sand-blast will be greater in the latter case, and so the same amount of sand will be deposited in a given time in both surfaces. In fact, while the area is directly proportional to the square of the radius of the circumscribing sphere, the density of the sand-blast is inversely so. If, therefore, we represent the depth of the sand at any point on the surfaces F and f, by e and E respectively, we have the relation :—

$$\frac{E}{e}=\frac{F}{f}=\frac{R^2}{r^2}$$

Now the depth of the layer of sand at any point on the surface of the sphere corresponds with the illumination which would be produced were the sand-blast replaced by a source of radiating light instead of sand. And just as the depth of the layer of sand alters in inverse proportion to the radius of the sphere so too does the intensity of illumination. Thus we arrive at the fundamental law of inverse squares according to which the intensity of illumination of a surface is inversely proportional to its distance from the source of light.

In the same way, too, as the depth of the layer of sand will vary according to the force of projection of the sand-blast in different directions varies, so the intensity of illumination in the surface of the sphere will vary according to the manner in which the intensity of the source differs in various directions.

We can also imagine that the amount of sand deposited on F in Fig. 1 was of the same value as above, but uniformly distributed. Under these circumstances we should compare this uniform depth E_m say, with the mean illumination over this area. This mean value E_m is obtained by simply dividing the total amount of sand deposited by the area F over which it is distributed. Thus the intensity of illumination E_m is connected with the flux by the relation :—

$$E_m=\frac{\phi}{F}$$

This law is not only applicable to surfaces on concentric spheres described around the source as centre but may be applied to any surfaces whatever, contained within a given solid angle.

Take, for example, the light strikes an element of surface F_1, at an angle α, where α is the angle between the normal to the element of surface considered and the direction of incidence of the rays of light. This surface is connected with the area F, which is cut out by the same solid angle, but diverted normally to the rays of light by the relation

$$\frac{F_1}{F}=\frac{1}{\cos\alpha}$$

But at the same time the depth of the layer of sand will be inversely in the above relation, and inversely as the area of the surface. We have, therefore,

$$\frac{E_1}{E}=\frac{F}{F_1}=\frac{\cos.\alpha}{1} \quad \text{or} \quad E_1=E\cos\alpha$$

The illumination received through rays striking the surface at an angle is thus $\cos\alpha$ times that produced by the same flux of light striking the surface normally. The illumination in the latter case is termed *Normal Illumination* (E_N). In the same way the intensity of illumination due to the light flux on a horizontal plane is termed the *Horizontal Illumination* (E_H).

This method of analogy may be applied to explain in a very simple fashion, the other chief photometrical terms such as *Intensity* (candle-power). For imagine that the sphere surrounding the sand-blast is described with a unit length as radius. The depth of the sand layer under these circumstances corresponds with the normal illumination, due to the source of light at a unit distance from the surface illu-

minated; this quantity serves to define the intensity of a source in any particular direction in space. If now the intensity in a given direction is I, and the normal illumination at a distance r from it is E_N, then utilizing the relation that the normal illumination in a given direction is proportional to the inverse square of the distance of the source illuminating the surface we have:—

$$\frac{E_N}{I} = \frac{1}{r^2} \text{ or } E_N = \frac{I}{r^2}$$

Thus we have arrived at the connexion between *illumination* and *intensity.*

(*To be continued.*)

The New Home of 'The Illuminating Engineer' of New York.

On June 1st, we learn, *The Illuminating Engineer* moved to its new and permanent home, at 36, West Thirty-ninth Street, New York. This consists of a typical four-storey and basement brown-stone mansion, which has been purchased by the Illuminating Engineering Publishing Company of New York, and will be redecorated and used for the publication offices of the magazine. It is the intention ultimately to erect a substantial modern office building on the site.

The position was selected largely owing to the fact that it is directly opposite the United Engineering Societies' Building, which is the nerve centre of all the technical societies of national scope. Besides this, the location has the advantages of being midway between the two great railway termini now nearing completion, but a short distance from the new public library, which will be opened some time within the present year, and within easy walking distance of the majority of the best hotels, theatres, shops and Fifth Avenue.

The Berlin "Palace of Ice."

By an Engineering Correspondent.

Our Berlin correspondent sends us some particulars of the lighting of a large artificial skating rink recently fitted up in Berlin, and termed the "Palace of Ice."

The building is of exceptional size, with a sheet of ice being sufficient to accommodate 1,000 to 1,500 skaters, while the galleries provide room for as many as 3,000 spectators.

Around the edge of the rink are distributed little alcoves, and recesses of tasteful design to which special methods of illumination are applied. The intention of these methods is to simulate the natural resemblance of winter, and yet to provide a strong and even illumination for the benefit of the skaters. The main lighting is provided by powerful chandeliers, hung in bronze chains, some of which will be seen in the illustrations opposite. Each of these contain an electric arc lamp and also a series of incandescent lamps surrounded by ornamental prismatic glass in different colours intended to imitate icicles. In addition, the galleries, &c., are illuminated by special hanging lamp fixtures, each containing five incandescent lamps all provided with frosted shades to imitate icicles; lamps of the same kind are used to outline the numerous arches.

The lighting is of an exceptionally lavish character, and the building generates its own electricity, the greater portion of which is used for illuminating purposes. There are, however, many other special electrical devices for ventilation, for driving kitchen machinery, &c., and other special purposes.

It is stated that it is unusual for any establishment in Berlin to generate its own current in preference to taking its supply from municipal mains, and it is only the large amount of power required that warrants the adoption of this plan in the case of the "Palace of Ice."

FIG. 1.—Illumination of Gallery of Berlin "Palace of Ice."

FIG. 2.—Berlin "Palace of Ice," Main Entrance to Skating Rink.

Light in Worship.

By Dr. M. Gaster.

In the next phase of evolution the light, which shone in the heavens and was worshipped as a god and as the origin of life, descended from above and became the companion of man and his assistant in his worship of the gods. Man could not remain satisfied merely with gazing at the light above, which was accessible to him but half of the time, only during the day, and then for a limited period often obscured and darkened by the evil powers which were anxious to retain the whole light for themselves or to extinguish it altogether and grudged it to the world below. The ambition of the human race has been to share with the gods in their possessions, notably in those from which man hopes to become like unto the gods. He would be anxious to get the means to protect himself against the same attacks of the evil spirits, to drive away darkness, to dispel the terrors of the night. But the gods do not grant anything lightly to mortals, and those who venture upon wresting their treasures from them have often to pay dearly for their daring.

The mythology of the Greeks, and that also of the North peoples, has preserved an ancient myth full of deep significance, which we may interpret in our own way with as much justification as they did in olden times. The light and fire of heaven could not be obtained by mortals unless by cunning and at the same time at a great sacrifice. Prometheus stole the heavenly fire and was therefore chained to the mountain and suffered unspeakable tortures. With him begins human civilization, all the arts are traced to his teaching, and the weal and woe of mankind is the result of his doing. To us Prometheus appears as the first martyr of science who has to pay a heavy penalty for his bold undertaking to bring light into darkness and order into chaos. It was rightly felt that with the acquisition of artificial light a new chapter began in the history of the world. Its divine nature could not be gainsaid, and it became part and parcel of the worship hitherto rendered to the divinities. No more fitting symbol of the gods than this intangible, everlasting, immaterial element the source of life and light, the vivifying, and at the same time the purifying, element in nature, destroying all the decaying matter and soaring upwards as it were to its origin above the skies; dissipator of darkness, turning the night into day and the gloom into brilliancy, driving away the enemies that stalk in the dark and assisting man in all his undertakings.

No longer dependent on the light of the day, fire (light) was henceforth associated with the ceremonial. Fire at the beginning was therefore "holy." The altar with the burning fire on it succeeds to the primitive worship in the open air. Within the walls of the temple some of the light outside was to be introduced to represent as much as possible that which originally was the immediate object of worship. A step forward had been made in the establishment of a more permanent form of expressing its allegiance to the powers that rule the world, and a lasting abode for the offering up of prayers for protection or thanks for mercies received. It is extremely interesting to find that light has been of necessity associated with the proper form of worship. No one thought it possible that it could take place in a dark room, or in any cave whither the rays of the sun could not penetrate, or where the gloom could not be relieved by some artificial light. The very combination of both darkness and light in the Egyptian temples, and in those built upon the same principle in later times is suggestive in the highest degree. In the temple, darkness was created artificially in order to tune the mind of the worshipper to a feeling

of awe and terror. When he entered he stepped suddenly into a shadow, made darker by the contrast of the bright daylight of an Egyptian noon, which he had just left behind. He found himself, as it were, in the abode of death, and his feelings were roused when suddenly a gleam of light stole through the darkness, breaking the terror and inspiring him with renewed confidence. He had only to follow the ray of light to find himself near to the shrine of his god, and to draw from him comfort and strength. The darkness was to create in the worshipper first a heightened religious tension, to make him realize his own human weakness and impotence in his endeavour to fight the powers of darkness, and then to lead him on to reliance on the power of light whose symbol he saw there dispersing the darkness. This is the reason why in so many churches, especially those built in the Middle Ages, unconsciously, or by premeditation the same principle is adopted to create a kind of chiaroscuro, and keep only a small light burning in the extreme end, before the image of a saint, the patron saint of the place or the church The intention was the same : to create a religious atmosphere and to deepen the impression.

In Egypt they so arranged the temples that only once a year the ray of the rising sun shot through the whole interior and lit up the image of the god seated at the extreme end, signifying thereby the birth and the revival. But what was possible in Egypt with its unclouded sky and the certainty of the sun rising at a given time was unattainable in every other country. Artificial light had to be resorted to, moreover, during the other days and nights, lamps were lit, or candles, or occasionally torches. But the "sacred fire" was the central part of the ceremonial. It should not be forgotten that it had come from above and a gift of that kind was not likely to be repeated. Every precaution had to be taken to keep it alight, and not to allow, under any circumstances, that it should be extinguished. It boded ill for the community, and brought trouble in its train. On the other hand, it had to be preserved from becoming polluted by any profane use. That fire which burnt in the temple was a "holy" fire, not kindled by human hands, and alone worthy to be used in the sacrifice.

We shall now follow up the "holy" fire in the religions of the East and West, and trace in it the part which was assigned to the fire in the ritual. From the sacred ritual we shall follow it up afterwards in its secular application, still being associated with solemn occasions and memorable events. The development is gradual, and its description is a chapter in the history of civilization quite unnoticed hitherto.

We might safely start from the Bible, as the best-known book. There we find in the first place the perpetual fire which had originally come from heaven and was to be kept burning on the altar. It was considered holy, and the extinction of it was regarded as a grave dereliction of duty. Any attempt to kindle it by human hands brought condign punishment. The two sons of Aaron who brought "strange" fire were killed on the spot. There is besides the burning light inside the temple the seven branched candlestick, which was also kept permanently alight. The worship was not considered complete without the accompaniment of the burning light, the symbol of the light above.

In India the Brahmin not only keeps the fire burning on the altar and worships Agni, the god of fire, with seven arms, but fire sacrifices are brought on every occasion of life, and more specially on betrothals and marriage ceremonies. Vows taken by Agni are sacred. Moreover, the Brahmin keeps up a permanent fire in his house, the object of his daily worship, and he expects that from that fire the brand will be taken to light the pyre on which he is to be burnt after his death, so that the fire and the light may purify him and carry him up to the heavenly abode from which the fire had come. Without referring to the sacred fire entertained in the Prytaneum in Attica, every one remembers the sacred fire kept up by the Vestal virgins in

Rome, which had been brought hither by the fugitives from Troy, as the old Roman legends aver, meaning thereby that the cult of the sacred fire had come to Italy from the East, the home of this "holy fire." This brings us back to the Parsis, known from ancient times as the fire-worshippers. Fire is considered by them as the purest representation of the heavenly fire, the origin of everything that lives, and the motive power of the world. With the extinction of fire life comes to an end, for cold is death and heat is life ; every action produces heat and light. They went so far in their praise of fire that they raised it to the position of being an object of worship, so sacred, that when kindling it they cover their mouths lest it become defiled by the breath. Their service is constant offering to the fire, and without a burning flame no worship is possible. The burning gases of the naphtha fountains in the Baku provinces were so many altars of the ever living element, and round them the ancient Parsis worshipped the fire as such, and kindled at them their own lights which they kept burning in their temples all over the ancient kingdom of the Sassanides.

Ascending then towards the North we find the counterpart of the Prometheus legend among the myths of the old Norse. Loki is the god of fire, the clever craftsman, and also one of the most cunning of the gods. He also suffers a similar punishment on the high mountains to which he is chained, and the poison of the snake drips on his face and makes him writhe in agony and produce earthquakes. Though we are not told expressly that he is punished for having stolen the divine fire and given it to mortal man, it is evident that such must have been the primary origin of that myth, which was later on obscured by further developments of the Norse mythology. Hephaestus and Vulcan, the great craftsmen who use the sacred fire for their wonderful metal works, are described either as being lame, or in some other way misshapen, no doubt in consequence of their fall from heaven. "No one dare play with fire" is an adage the truth of which the first pioneers had to experience in their own persons, and thus it has remained to this very day.

(*To be continued.*)

Further Examples of Gaslighting in Birmingham.

In our last number we commented upon the lighting of the large lecture theatre at the Midland Institute, referring to some information on this subject to our contemporary, *The Journal of Gaslighting*, to whom, and also to the courtesy of Mr. G. H. Barber, the Secretary to the Birmingham Corporation Gas Dept., we are again indebted for the loan of blocks.

The use of high candle-power sources high up is again to be noted favourably in the halls shown in Figs. 3 and 4, and it is probable that good gaslighting is shown under favourable conditions in lighting these large areas.

The photographs, it is stated, were taken without the aid of artificial light, and, indeed, the daylight illumination in St. James's Church is said to be so dim, owing to the heavy glass windows, as to render photographs under natural conditions almost impossible This, by the way, is an interesting example of the difference in the natural and artificial conditions which seem to prevail in many churches.

Data referring to these buildings :—

	Friends' Hall.	Wesleyan Chapel.	School of Art.	St. James's Church	Midland Institution.
Seating accommodation—persons	1200	1000	—	900	1000
Number of gas-burners	46	44	25	58	80
Consumption of gas per hour—cubic feet	230	220	100	224	400
Total illuminating power	3680	3520	1750	4040	6400
Cost for lighting, per hour	5·03d. (1)	5·85d. (2)	2·18d. (1)	5·96d. (2)	8·74d. (1)

(1) Gas at 1*s*. 1*d*. per 1000 cubic feet, less 5 per cent. (2) Gas at 2*s*. 4*d*. per 1000 cubic feet, less 5 per cent.

FIG. 1.—School of Art (Brass-worker's Room).

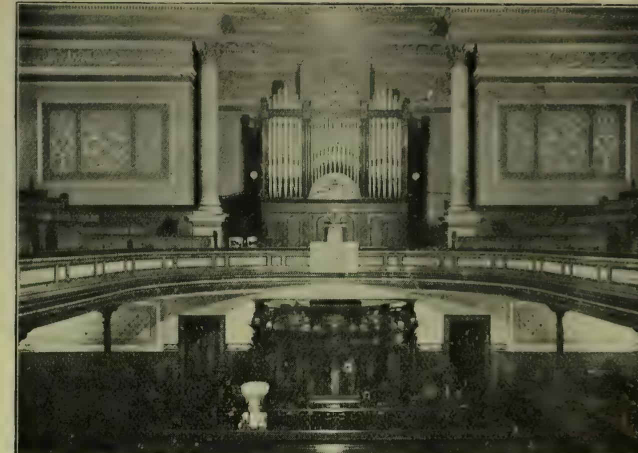

FIG. 3.—Wesleyan Chapel, Moseley Road.

FIG. 2.—St. James's Church, Edgbaston.

FIG. 4.—Friends' Hall, Moseley Road.

Some Examples of Gaslighting in Birmingham.

(For the use of these blocks we are indebted to the courtesy of the *Journal of Gaslighting.*)

On the Name of the "International Candle" Unit.

By M. A. Blondel.

In our last two numbers we made special reference to the important announcement regarding the proposed international unit of light, which is to be identical in value in France, Great Britain, and the United States. On the value of such an international unit there is general agreement.

M. Blondel, however, who has already done so much to facilitate international agreement on these points, draws attention to a possible cause of confusion in the following note, pointing out that, now that agreement on a common unit has been achieved, it is also desirable that there should be a common name for it. We invite correspondence from our readers on this question.

1. "Candle" is the name of a material object. It is as unscientific to call the unit of intensity an "international candle" as it would be to call the unit of electromotive force an "international battery," or the unit of heat an "international stove," &c.

2. The term "international" is cumbersome, and is too long either to write or pronounce with convenience, and people will therefore be inclined to allow it to drop. Thus confusion with the other existing candles in different countries will inevitably occur.

3. The names and symbols of the unit would be different in the case of different languages; moreover the derivation in each case is distinct, as the following table shows :—

Language.	Name.	Derivation.	Symbols.
English	International candle	Lat. *candela*	I. C.
French	Bougie internationale	Chandelle de Bougie (a city near Algiers)	B. I.
German	Internationale kerze	Lat. *cerata* (French cierge)	I. K.

I doubt very much whether a unit can be adopted as international, unless its symbol is the same in the various countries.

For all these reasons I should propose to adopt rather a new name; either a Greek name, such as "pyr," or "phos," or a scientist's name, such as "Violle."

M. Violle is the creator of the bougie decimale, which he proposed, and which, at his recommendation, was adopted by the International Electrical Congress of Paris, 1889; by his former work he seems to be legitimately entitled to that honour.

The symbol could be the same for all countries: "V" or "Vi."

In practice, the word "Violle" could be abridged in "Viol," like "Faraday" in "Farad."

Initially, in order to comply with the existing custom, each country could associate the name of the unit with the name of the material object actually employed, and say, for instance:

"25 Viol candles" or "25 V. candles"

Just in the same way as the Germans now say:

"25 Hefner-Kerzen."

When expressing a measurement of a spherical or an hemispherical candle-power the sign $\ominus$ or $\overline{\cup}$ or $\underline{\cap}$ should be added after the symbol "Vi." These signs differ from those proposed by the Zurich Committee only in the addition of an horizontal bar; experience has shown me the necessity of the bar for convenience in writing and in order to avoid confusions with a zero; the signs proposed by the Zürich Committee are not sufficiently distinct and characteristic.

A Method of Illumination of the Past.

THE accompanying illustration is taken from the comprehensive work on ancient methods of illumination by von Benesch (Das Beleuchtungswesen vom Mittelalter zur Mitte des XIX. Jahrhunderts aus oesterreich-ungarn, Verlag von Anton Schroll & Co., Vienna), to which we have already referred in our July number (p. 491), and with which we hope to deal in detail shortly.

It represents the early method of lighting by means of splinters of resinous wood—pine and so forth—a primitive method which was long almost the only means of producing light, and is said to be still utilized largely in many remote districts to-day.

The forge shown in the illustration is situated at Mühlviertel in Upper Austria. It will be seen that the splinter is gripped in an iron support on the anvil, which it is intended to illuminate. The iron support can be rotated on its axis and otherwise adjusted so as to throw the light in any desired direction.

Such iron supports were often made in the form of crosses, serving the double purpose of providing light and supposed security from witchcraft, &c.

No doubt this is one of those instances of the association of light with ideas of a religious or semi-religious nature, on which Dr. M. Gaster has recently commented in these columns.

Public Lighting.

[Report of the Deputation appointed by the Streets Committee of the Corporation of London to study the lighting of continental cities.]

To the Honourable the Streets Committee of the Corporation of London.

We, the undersigned, the Deputation appointed to visit certain Continental cities for the purpose of inspecting the various systems of public lighting, beg to report that we visited the following cities, viz.:—Brussels, Cologne, Düsseldorf, Berlin, Dresden, Vienna, Munich, and Paris.

We submit particulars of the different systems of lighting which we inspected, from which it will be seen that in every city, gas as well as electricity is used.

We also append particulars of the lighting in the City of London.

In Brussels.—The main thoroughfares, squares and market places are lighted by means of electric arc lamps, with an ordinary incandescent gas burner on each side. The arc lamps are turned off at midnight, after which time the lighting is supplied by gas. The side streets are lit with incandescent gas.

Cologne.—The important streets of the city are lit by centrally hung electric arc and flame lamps, with lowering gear, the open spaces by a combination of electricity and gas, and the minor streets mainly by incandescent gas lamps upon standards.

Düsseldorf.—This city is lit in a somewhat similar manner to Cologne, arc lamps centrally hung and upon standards, and by incandescent gas.

Berlin.—The general arrangement for lighting is by means of electric arc lamps, centrally hung and upon standards, electric glow lamps, and high-pressure incandescent gas lamps with inverted mantles.

Dresden.—Electric arc lamps of the "open" and "flame" type are used in this City, a considerable number being suspended across the centre of the streets, with side lowering gear. Electric glow lamps are also used. The side streets are lit with low-pressure incandescent gas lamps. The electric arc lamps are switched off at midnight, leaving incandescent gas lighting only.

Vienna.—Electric arc lamps upon standards with incandescent gas lamps fixed upon brackets below, together with low-pressure incandescent gas lamps fitted with upright and inverted mantles.

Munich.—Electric arc lamps centrally hung and upon standards, also electric glow lamps and low-pressure incandescent gas lamps.

Paris.—Electric arc lamps upon standards, and low-pressure incandescent gas lamps.

Having very carefully considered the various systems, we are of opinion that the public lighting in the City of London can be materially improved, and we have come to the following conclusions:—

(1) That, wherever possible, streets should be lighted by means of centrally hung lamps with lowering gear.

This we think particularly important in the City of London, where the number of obstructions upon the footways in the form of lamp-posts, bins, letter-boxes, &c., is so large.

(2) That open spaces should be lighted by means of lamps upon standards, fitted with lowering gear.

(3) That high-pressure incandescent gas lamps with inverted burners should be adopted as the illuminant, but where gas is impracticable, electricity with open arc and flame arc lamps should be installed.

We think, however, before suggesting any drastic alterations in the general lighting of the City, that the Streets Committee should be authorized to

arrange for some further experimental lighting of the City thoroughfares, and we recommend accordingly, and that our Report, with the particulars of our recent inspection, be in the meantime printed and circulated for the information of the Court.

In conclusion, we desire to place on record our appreciation of the facilities afforded by the various Municipalities for our inspection of their systems of lighting and for the kindness and hospitality we received.

All which we submit to the judgment of your Honourable Committee. Dated this thirtieth day of June, 1909.

Charles Alfred Teuten, Benj. Turner, John Stopher, Jos. Gunton, G. Gordon Stanham.

[The report proceeds to describe the lighting of the other towns visited, with which we hope to deal in our next number. On the present occasion we confine ourselves to Berlin; the lighting of this city is, at the present moment, of special interest.]

Berlin.

Gas is manufactured by the Municipality, but electricity is purchased in bulk from a private company.

The total number of electric arc lamps (open and flame) in Berlin is 864, supplied by direct current. 664 of these lamps are fixed upon standards, and 200 are suspended across the streets centrally hung. The distance between the open lamps is from 100 feet to 130 feet, and 98 feet between the flame lamps. The open and flame lamps are fixed at heights of 26 to 31 feet, a few flame lamps being 52 feet high; one-half of the lamps are extinguished at midnight.

Two hundred and twelve electric glow lamps are used in the City, 177 being of the Nernst type, 14 carbon filament lamps, and 21 metal filament lamps, the carbon filament lamps giving a light of 14 candles and taking 57 watts per lamp, the metal filament lamps being of 440 candle power and taking 440 watts per lamp.

High-pressure gas lighting is very largely and effectively used in Berlin, twenty-five miles of streets being lit by 1,531 lamps fitted with upright and inverted burners, two and three burners in each lantern; they are supplied direct from four separate compressing plants at a pressure of about 53 to 78 inches (water-gauge). The newest type of lamps, viz., the "Graetzin" high-pressure inverted lamp, being fitted with three burners per lantern, giving an illuminating value of over 4,000 candles, two burners being extinguished at midnight. The distance apart of these high-pressure lamps is from 90 feet to 100 feet, and the average height of the lamps above the roadway, measured from the burner, about 19 feet.

Gas manufactured by the Municipality is of 12 candle power, *unenriched*, but tested by the "Metropolitan No 2" burner, a light equal to 14 or 15 candle power is obtained—the price of gas was stated to be 1*s*. 4½*d*. per 1,000 cubic feet for public lighting purposes. The calorific value (heating power) of this gas is 540 B.Th.U. (British Thermal Units) or 135 calories (gross). This compares favourably with the proposed calorific standard for London gas, viz., 14 candles, 500 B.Th.U., or 125 calories (gross), as inserted in the Gas Light and Coke Company's Bill before Parliament this Session.

The Deputation was informed that the Berlin authorities have decided to spend seven million marks (350,000*l*.) in installing the latest patterns of high-pressure gas lamps with *inverted burners* in lieu of the existing gas and electric lamps. Expenditure in this direction has been going on for two years at the rate of one million marks (50,000*l*.) a year, and will be continued at the same rate for the next five years. The lamps used are graded according to the importance of the thoroughfares—at junctions of main streets, lamps of 4,000 candle power; in main thoroughfares, lamps of 2,000 candle power; and in other streets, lamps of 1,000, 600, 400, and 200 candle power, the 400 and 200 candle power lamps being on low pressure. So far as gas is concerned, four-fifths of the city is lighted by the Municipal authority, and the remaining one-fifth by the Imperial Continental Gas Association. In some streets where the Municipal Authority and Association meet, the latter are putting in the same kind of burner as the former.

Incandescent gas lighting (low-pressure) is used for the side streets, there

being about 466 miles of streets lighted by 3,000 upright burners and 2,600 inverted burner lamps. The upright burners consume about 4¼ cubic feet, and give 63 to 70 candle power light, and the inverted burners consume about 3½ cubic feet and give about 100 candle power light. The lamps are fixed from 82 to 92 feet apart on the diagonal, at an height above the roadway, measured from the burner, of 11 ft. 6 in. to 14 ft. 6 in.

At the present time the principal streets are lighted with high-pressure inverted incandescent gas lamps of the following type :—

Lamps consuming—

Cubic ft. of Gas per hour.			
21·2	Giving a light equal to about	636 candles	(Upright burner)
28·26	,, ,, ,, ,,	1,000 ,,	(,, and single burner).
42·4	,, ,, ,, ,,	1,364 ,,	(,, burner).
42·4	,, ,, ,, ,,	1,540 ,,	(Inverted, 2 burners).
53·0	,, ,, ,, ,,	1,636 ,,	(Upright, 3 ,,).
84·8	,, ,, ,, ,,	3,367 ,,	(Inverted, 3 ,,).
*84·8	,, ,, ,, ,,	4,364 to 4,550 ,,	(,, 3 ,,).

* This is the newest type of the "Graetzin" lamp, two burners of which are extinguished at midnight, the upkeep not exceeding that of the 3,367 candle power lamps.

In future incandescent gas lighting only will be used in Berlin.

The "Graetzin" high-pressure gas lamp, named after the inventor, Herr Graetz, of Berlin, is a 3-burner inverted lamp, made to connect on to a compressing plant at about 54 to 67 inches pressure (water guage) or 4 to 5 inches of Mercury. It uses three of the large size inverted mantles, and its estimated candle power is about 4,800 to 5,000 German, or 4,364 to 4,555 English candles, single burners giving about 1,400 to 1,500 English candles according to the Berlin photometrical tests; the gas consumption per hour of a three-burner lamp is about 84·8 cubic feet, *i.e.*, 28·2 cubic feet per burner, therefore the approximate lighting efficiency is about 51 to 53½ candles per cubic foot of gas consumed. The efficiency claimed is stated to be from 45 to 55 candles per foot of gas. The lamp is so made that two burners can be extinguished at midnight or any other arranged time, leaving one alight for the remainder of the night. Its dimensions over all are 3 feet 9 inches by 2 feet 2 inches. Its weight is 86 lbs.

It is stated the mantles at the present time are in use for about 9 days; it is, however, probable that the life of the mantle will be lengthened. One attendant serves about 50 lamps, that is, he has to clean them, replace the mantles, &c. The extinguishing and lighting are carried out automatically by change of pressure; after midnight, however, it is done by hand.

The streets will be divided into classes :—

1st class streets will have inverted high-pressure gas lamps of 4,000 candle power

2nd class streets will have inverted high-pressure gas lamps of 2,000 candle power.

3rd class streets will have inverted high-pressure gas lamps of 1,000 candle power.

4th class streets will have low-pressure inverted lamps of 600 candle power, each candelabra having 2 lamps with three burners each.

5th class streets receive low-pressure inverted lamps of 400 candle power, each candelabra having 2 lamps with 2 burners each.

6th class streets receive low-pressure inverted lamps of 200 candle power, each candelabra having 1 lamp of 2 burners.

The candelabra still existing with 3, 2, and 1 upright mantles are being used up, and are gradually disappearing, giving place to inverted burner lamps.

(*To be continued.*)

The Lighting of the City of Boston.

By our Boston Correspondent.

In our July number we gave some particulars of the method of lighting decided upon by the authorities in the City of Boston, U.S.A.

From our correspondent in this city we have received a copy of the published letter from the Superintendent of Streets to the Mayor of Boston, in which further details are mentioned and some account given of the grounds which influenced the authorities in their decision. This letter we are reproducing. We are also informed that the city is now considering the question of the minor lighting of side streets, &c.; this is at present done with incandescent gas, by an intermediary company which buys gas from the Supply Company and supervises the lamps in which the gas is utilized.

To the Honourable the Mayor :—

In answer to your request for a concise statement of the negotiations leading to the contract with the Edison Electric Illuminating Company for street lighting just executed, I submit the following, as briefly as due consideration of the importance of the matter and of the extent of the negotiations will allow.

The previous contract for electric lighting in Boston was made February 20, 1894, for a period of five years, with the Boston Electric Light Company. The contract was signed by Patrick O'Shea, Superintendent of Lamps, and approved by Nathan Matthews, Jr., Mayor. On August 29, 1898, this contract was extended for a term of ten years from and after February 20, 1899. This extension is signed by James Donovan, Superintendent of Lamps, and approved by Josiah Quincy, Mayor. On the 26th of February, 1901, an assignment was made by the Boston Electric Light Company to the Edison Electric Illuminating Company by Acting Superintendent of Lamps William Jackson, approved by Thomas H. Hart, Mayor.

The original price for the Gilbert lamp under this contract was $127·75 per year, which price was continued until August 20, 1906, when, in accordance with the provision contained in the arbitration clause of the contract, the price was reduced to $118·39. This price the City has been paying up to the present time, the contract expiring February, 20, 1909. Since that time the Company has been furnishing lights under the clause of the contract which provides that six months' notice must be given by either party before the termination of the contract. With a view to gaining information regarding a new contract, I have made visits to the various large cities along the Atlantic Seaboard, collected imformation from both domestic and foreign sources, and called into consultation such persons as seemed to me willing and competent to give advice in the matter. My investigations led me to conclude that the demand at the present time is toward what might be termed spectacular lighting, or more brilliant illumination for streets. Communication with the Edison Company brought an offer that this company would demonstrate any lamp, either of foreign or demestic manufacture, that might be desired; and in accordance with this offer, demonstrations of several lamps were made, among them the Jandus Flaming Arc Lamp, the Blondel, the 4-ampere Magnetite, the Nernst, the Adams-Bagnall "Titanium," Oriflamme Magazine, Excello and the present General Electric flaming arc and the Magnetite lamps. These latter two lamps being of the latest model and the most powerful of their type, were adopted as the basis of the new contract. The Magnetite lamp was an especially attractive proposition, on account of the brilliancy of its illumination and the character of the light given. The flaming arc lamp was considered as a valuable lamp for large open spaces and to be used in very limited numbers. An examination of the Magnetite lamp, as regards its reliability, discloses the fact that in November, 1908, 24,189 of these lamps were in operation in eighty cities and towns of the United States, and that since that time their numbers have been largely increased. Among the more prominent cities using these lamps were Baltimore with 1,625, Fall River with 1,000, Toledo, Ohio, with 1,800, Portland, Oregon, with 1,725, Syracuse, New York, with 1,500, and Worcester, Mass., with 1,000. These Magnetite lamps are smaller lamps, requiring but two-thirds of the current of the lamp adopted for Boston, and of about one-third the illuminating power,

being slightly superior in illuminating power to the Gilbert lamp, which we now have, but much more economical of current. The lamp adopted for Boston was identical in material and construction with the above lamps, except that it is much more powerful. A number of these lamps were installed in the streets of the City of Boston, and frequent tests and observations were made to confirm their character. In all tests they fulfilled entirely the claims of their manufacturers. A tentative agreement was therefore reached for furnishing these lamps at the prices given in the preliminary draft of the contract sent you, viz. :—

Gilbert	.. ..	\$103·54 per year
Magnetite	.. ..	110·81 per year
General Electric	..	156·27 per year

In the matter of the Magnetite lamp, the Edison Company assured me of its confidence that during the present year these lamps could be reduced to the price of the Gilbert lamp, the difference between \$103·54 and \$110·81 being entirely on account of the electrode, the price of which was being rapidly diminished on account of improved methods of manufacture. Later, on account of delay in signing the contract, the predicted improvements were of such a nature that I was able to secure from the President of the Edison Company a contract, which was later approved by you, in which the price of the Magnetite lamps was made \$103·54—upon provision, however, that all Gilbert lamps in excess of 500 should be replaced with Magnetite lamps. These Magnetite lamps show by our tests approximately three times the candle-power at a given angle of the Gilbert lamps. A price of \$92·39 was secured for the Gilbert lamp for the small number. The principal advantage of this price is that the contract was made to take effect April 1 of the present year, and until such time as the Edison Company may be able to instal the Magnetite lamps, the City will receive great benefit from the reduction, the saving on April bills being in excess of \$8,300.

During my negotiations, I exhausted every avenue open in the attempt to find some form of competition with electricity for street lighting, or by appeal to public boards to force the Edison Company to a lower price. Consultation with the Board of Gas and Electric Light Commissioners, through their chairman, convinced me that nothing was to be hoped for in that direction, although I was informed that "in case I was able to obtain lower prices from the Edison Company, the Gas and Electric Light Commissioners might take means to require the Edison Company to give the same prices to surrounding municipalities." This avenue was therefore abandoned.

The matter of gas lighting in competition with electric lighting was duly considered. Reports were gathered from foreign sources, and several propositions in the form of letters through your office were submitted from the Boston Consolidated Gas Company—notably, for the installation of the so-called Graetzin low-pressure lamps and for high-pressure lamps in competition with the electric arc. An installation of Graetzin lamps was made on Commonwealth Avenue, and one high-pressure lamp was installed in front of the Gas Company's Office on West Street. Frequent tests of the Graetzin lamp convinced me of its efficiency and its value as a possible competitor with the Welsbach low-pressure lamps; but its candle-power was found to be less than half the amount claimed by the Company. Whether this was due to defects in the lamps or inferior quality and low pressure of the gas furnished, I am unable to say. I am inclined to the opinion that it was the latter, as I find that in general our Welsbach lamps which are guaranteed for sixty candle-power do not average greatly above forty candle-power. It was also found that the Graetzin lamp was extremely susceptible to various adjustments on account of the weather conditions. This lamp was therefore eliminated from consideration in connexion with this contract.

The proposition for pressure lamps made in the letter of President Richards of the Gas Company, under date of April 5, was so exceedingly vague regarding the character of the lamp proposed as to be of little value, and verbal interviews with Mr. Richards did not tend to throw more light on the subject.

The matter of European cities where pressure gas has been installed was gone into thoroughly, so far as information could be obtained. It seems clear that pressure gas has (neglecting cost) been made a success both in Berlin and in London. It also seems clear that no serious competition has been possible between the press gas and the flaming arc lamp, although press gas is undoubtedly superior to the ordinary inclosed arc similar in type to the Gilbert lamp. I found peculiar reasons for the installation of these lamps both in Berlin and in London, although the price for the same amount of illumination seems to be much greater in both cities than for electric

lighting, amounting in Berlin to $259 per lamp year for a two-mantle lamp. I find that these lamps were installed in Berlin largely on account of sentiment and in response to the demand of labour unions, added to the fact that the municipality has in the neighbourhood of $20,000,000 invested in a municipal gas plant. In London the incentive was on account of the exceeding low price of gas, the low price of labour, and the fact that electric mains have not been generally installed in the streets of London, and therefore, to prevent the frequent digging up of streets. This objection, you will understand, does not apply to Boston electric lighting, as underground conduits have already been installed in the greater portion of its area, but would apply to a pressure gas installation.

About 200 of these lamps were at one time installed in Frankfort-on-the-Main, and operated for two or three years with varying degrees of success. They were finally abandoned as being impracticable.

In this country no attempt has been made to instal press gas, except for experimental purposes, although I am told that the matter was investigated by a number of experts, who visited Germany in the interests of the City of New York, and who reported the system to be impracticable. The weakness of the press gas lamp seems to be due to its enormous operating cost, and the greater percentages of outages and accidents, which is estimated by a prominent authority as five times the amount for low pressure gas, due to the fact that mantles on these lamps last only from six to eight days, according to report of English experts; and although lamps are nominally rated at the combined candle-power of all their mantles, as a matter of fact, it requires three mantles to maintain two-mantle candle-power, one mantle being out of commission practically all the time. Besides these weaknesses, the variation in candle-power, as shown by our tests, is much greater than for the electric arc, and particularly, for the Magnetite arc lamp. While it is not denied that the arc lamps vary in candle-power in a particular direction, they do not vary as a whole—the variation being due to the shifting of the arc from one side of the lamp to the other and a consequent change in the direction of the illumination. With press gas, on the other hand, any variation in pressure or climatic conditions cause an abrupt change, which materially affects the total candle-power.

The letters received from the President of the Boston Consolidated Gas Company, in connexion with his offer to instal press gas lamps on Boston Common, are so evasive in their nature and so peculiar regarding the information that they conceal, that detailed attention is interesting. Taking a letter of April 5 as an example, Mr. Richards states that "the ordinary type of gas street lamp" gives about 20 candle-power per cubic foot of gas. Our test show that our present Welsbach lamps give approximately 13 candle-power per cubic foot of gas, and the Graetzin lamps installed by Mr. Richards's Company less than 15 candle-power. Tests of the single high-pressure lamp installed on West Street show that the candle-power per cubic foot of gas is about 30, instead of 73, as he states. On p. 2, in the matter of the table given at the bottom of the page, I am reliably informed that the figures given are not the figures of the New York Electrical Testing Laboratory, as stated. It appears that but one Graetzin lamp has been tested by this Company under laboratory conditions. This test was made for a gentleman unknown to me, who was expecting to become the agent of these lamps in this country. The tests not approaching his ideas in candle-power or gas consumed, the New York Laboratory was requested to adjust its figures of candle-power to a theoretical gas consumption. This it refused to do, although it has evidently been done by other parties.

On p. 3, I am informed by Mr. Ryan that the table credited to him, there given, was not compiled by him, although to a certain degree the statements made are true. He states that it is probable that some curves plotted by him from another lamp than the Gilbert or Graetzin lamp have been adopted by the author of this letter and modelled to suit his purpose. A statement by Mr. Ryan is herewith enclosed.

Attempt has been made to confound the Graetzin lamp spoken of on p. 4 with the lamps included in our new contract. Mr. Stahlgren, agent for this lamp, informs me that it was never his purpose, in allowing an installation of lamps on Commonwealth Avenue, to attempt competition with the electric arc lamp, and he frankly admits that he cannot do so. His only desire is to compete at the proper time with the present low-pressure Welsbach lamps. In this connexion, I would call your attention to the fact that the 80 candle-power tungsten incandescent lamp for $27·85 included in the contract, which actually gives the rating attributed to it, is a more powerful lamp than the

Graetzin lamp, and at a considerably lower price; and an instructive comparison may be made by any interested citizen of the light on Commonwealth Avenue, between Arlington and Clarendon Streets. Between Arlington and Berkeley Streets, 16 Graetzin lamps, at $35 each, gave a total candle-power by tests at 20 degrees from the horizontal of 1,600, at a cost of $560 per year, or 2·85 candle-power per year for $1·00. Five Magnetite lamps, between Berkeley and Clarendon Streets, at $103·39 per year, give a total of about 7,500 candle-power at a cost of $515 per year, or 14·6 candle-power per year for $1·00

The statements in the middle of p. 6 regarding the relative merits of the press gas and the flaming arc lamps, appear to be without foundation.

P. 7, which contains the offer to instal press gas on Boston Common, is remarkable in its vagueness. No information is given as to the "independent technical authority." No information is given as to the number of mantles on this lamp, although Mr. Richards informs me verbally that it is not the same lamp that has been lnstalled on West Street. No information is given of the fact that the test was in all probability a laboratory test, and that the candle-power under service conditions, judging from the lamps already installed, would not be mone than one-half the candle-power given. No information is given that the candle-power is German candle-power, which is only 88–100 of the British candle-power in use by us, and that therefore the figures should be reduced by over 13½ per cent. He does inform me, however, verbally, that this lamp will use approximately 25 cubic feet per burner per hour. This is approximately the amount used in Berlin, although the Berlin gas contains a much greater number of heat units than does our Boston gas. Assuming for the purpose of calculation that the proposed lamp is a two-burner lamp, burinng 25 cubic feet per burner per hour, this would entail an expenditure of 200,000 cubic feet of gas per year, which at the rate charged at present by the Gas Company would amount to $160 per lamp for gas alone, not including cost of installation, laying the mains and the construction and operation of a pressure plant. It is clear that the lamp proposed by him would be considerably inferior to the present Gilbert lamp, and probably not over one-third of the illuminating value of the Magnetite lamp. The price, you will observe, also, is somewhat higher than for the Magnetite lamps, and the installation of the system would require digging up every street in which the service was installed.

The true comparison of the value received from the electric arc is the price of electricity per kilowatt hour. By this method, all lamps, whatever their power, may be reduced to the same basis; and I append a statement of the price per kilowatt hour of the various lamps that have been discussed through the public prints in comparison with the proposed Magnetite lamps. An examination of rates in large Eastern cities shows that nearly a uniform schedule exists, modified only by conditions, such as price of coal and labour and investment in underground construction.

The above are, as brlefly as I can give them, the reasons which influenced my judgment in the present contract, and I can see no reason at the present time to change my opinion. Some criticism has been made from the fact that a board of experts was not employed. Such advice was secured, although I found it very difficult to secure expert advice not allied with either one interest or the other. Moerover, I felt myself competent to form a fairly accurate opinion from the facts presented, and such facts I endeavoured to obtain. Advice was offered me during my negotiations by one gentleman only, and the present contract coincides with his ideas as stated by me; and in connexion with the various statements purporting to emanate from the Merchants' Association, I wish to state that no advice was offered by any member of this Association at any time, although I am informed by a member of your office that the Secretary of the Merchants' Association was several times advised and actually asked to confer with me regarding the contract.

The contract follows very closely the lines of previous contracts. In my opinion, it is perfectly adequate and the arbitration provision is an improvement on preceding contracts. Except for a few technical considerations the contract was entirely prepared by the Corporation Counsel.

Tests substantiating the statements, herein made are on file at this office.

I return herewith various documents, notably letters from President Richards of the Gas Company, which have been transmitted through your office in this connexion.

Very respectfully,

(Signed) Guy C. Emerson.

Superintendent of Streets.

High Duty Gas Lighting.

BY THOMAS HOLGATE, M.Inst. C.E., F.C.S.

(*Continued from p.* 461.)

2. *Pressure of Gas Supply.*—The proper adjustment of the quantity of gas to the burner is often determined by the use of a governor which controls the pressure, and which with an unchanging specific gravity of gas and unvarying gas orifice will secure a uniform delivery per hour. Of such a type is the Stott governor, because its function is to maintain a constant pressure on its outlet, irrespective of the rate of flow of the gas.

Frequently, however, volumetric governors are employed and these have the advantage of supplying the definite quantity irrespective of change of density of the gas, but they are not absolutely satisfactory when the changes of inlet pressure are great.

But whether the adjustment of quantity is by the governor, or by the hand of the consumer on the gas tap, the question of the velocity at which the gas emerges is of practical importance. It is this property which will determine the efficiency of the gas to drag in air at the mixing bulb. As a high velocity is desired, it is necessary to have a high gas pressure to secure that velocity. But this must be combined with no increase in the gas flow, which means of course a fine orifice with gas moving through it at a high speed. What that speed must be will be determined by the composition of the gas as already explained. It will also be affected by the form of burner employed. If the burner is upright, less gas pressure is sufficient to carry in the necessary primary air than if the burner be inverted. Also if the gas or air are preheated they will, for a given weight, occupy a greater volume, and these must be set in motion, in the required direction, by a greater velocity being impressed upon them. These two factors explain why the high pressure burners of to-day are needed, and why that high pressure enables recuperation to be accomplished in its most convenient and compact form.

In Mr. T. Glover's tests of ordinary inverted burners the pressure ranged from 2 in. to 2·5 in. water column, a very modest pressure, but yet distinctly higher than is necessary for an ordinary upright.

3. *Quantity of Gas per hour.*—The volume of gas will of course be determined by the size of the mantle to be filled with flame, but for any given size of burner and mantle, there are three possible maxima (*a*) the maximum of the total candle-power from the mantle, (*b*) the maximum candle-power per cubic foot of gas consumed, (*c*) per British thermal unit (net) used per hour. The last named is the one which usually carries the greatest economy to the user, and if this be considered somewhat fully the others will be easily understood.

The actual realization of the highest duty is in practice dependent upon an ample supply of primary air, which ought to be about 90 per cent. of the quantity required for complete combustion. The quantity of gas that it is desirable to burn is therefore conditioned mainly by the amount of air that each cubic foot of that gas requires, and the capacity of the burner to admit the requisite volume of air. Supposing then that this important element has been duly provided, may we say that the efficiency per cubic foot of gas will be in proportion to the net calorific value of the gas used? It has been stated by various writers that such is the case, but probably without a sufficiently clear explanation as to how far the assumption is valid.

The laws of the production of light assign a great accession of illuminating power with every small increase of the temperature of the incandescent body, and to this fact there appears to be no exception. Rather all the recent developments of gas lighting point to its supreme importance. The gas and air mixture (all other things being equal) which gives the highest flame temperature is the one which will be the most efficient in radiating light. Now eminent chemists like M. St. Claire Deville, have stated that for all practical purposes net calorific value in town's gas is all that need be considered. And this opinion is based upon a large number of tests of rich and poor gas mixtures. But it must be pointed out that most of these gas mixtures gave theoretical flame temperatures that were nearly equal. The determination of the actual flame temperature has been beset with difficulties, but if meanwhile we may use Deville's estimates we can draw useful conclusions. They show remarkably small variations between the richest and lowest quality gases; but divergences in individual gases, such as carbon monoxide 2140°, methane 1889° as extremes, with benzene 2090° C, and hydrogen 1995° C, as intermediaries ....must be noted. The writer has examined the results of Deville's tests and finds that the effects of flame temperature can be traced in the case of water gas as compared with coal gas, and these will be given in detail under the head of flame temperature. With these reservations, it will be understood that efficiency may be predicated in relation to the net calorific value of the gas used.

4. *The Distribution of Light.*—It is nowadays possible to select an incandescent burner suited to almost any kind of distribution that may be required in practice. The vertical burner if unshaded will give a spherical illuminating power, comprising an efficient lower hemisphere with an efficient upper hemisphere. Whilst shaded it will give a lower hemisphere that can be made to suit the most exacting needs, whether severely local or amply dispersed. The inverted burner worked with gas at a low pressure will furnish when unaided by reflectors a lower hemisphere in which the maximum intensity is immediately under the burner. When aided by a reflector having surfaces at a suitable inclination this concentration of light may be modified; but it would appear that the type is particularly well suited for the illumination of relatively small areas per unit. In many cases this need be no drawback, inasmuch as a liberal distribution of units conduces to uniformity of lighting at a minimum cost. Where such a multiplicity of units is not practicable, or on other grounds undesirable, the high pressure inverted type is pre-eminently suited. The general truths here referred to may be seen by comparing Tables I. and II., and the relative usefulness as to distribution of these types may be gauged by the ratios existing between the horizontal and vertical values towards the mean value. In the subjoined comparison the first two lines embody the experiments already described, the third and fourth lines are inserted as estimates showing relatively and only approximately the behaviour of the older tpyes.

Type of Burner	Candles per cubic foot of gas			Ratios to average of	
	Horizontal	Vertical	Average	Horizontal	Vertical
Ordinary inverted burner	16·7	28·7	20·02	0·83	1·43
High pressure ,, ,,	68·4	36·48	56·09	1·22	0·65
Ordinary upright burner	22·0	16·6	20·0	1·10	0·83
High pressure ,, ,,	44·0	33·2	40·0	1·10	0·83

5. *Constancy of the most favourable conditions of working.*—The preceding paragraphs have attempted to show the incidence of the several factors upon the final result, but it is also necessary to consider how far these can be realized in practice. The elements of variation in any properly

designed installation will in the last analysis centre in the composition of the gas, for although the pressure in the gas mains will vary from time to time, yet these fluctuations need not reach the consumers' burners.

It would appear that whilst for electric lighting, the crucial factor is the constancy of pressure, that of incandescent gas lighting is the chemical composition of the gas. I take as my authority for the first part of this statement the words of Mr. J. B. Clarke in *The Illuminating Engineer*, p. 393, vol. i., May, 1908. "A 5 per cent decrease in the voltage at the lamp terminals gives an efficiency of 74, or a reduction of approximately 26 per cent in the illuminating power of the lamp. Even 2 per cent decrease of volts produces a considerable reduction in the candle-power which on an installation of, say, 80 16 candle-power lamps accounts for a loss of approximately 160 candles." Fortunately in the quality of gas supply, with a comparatively large change in the relative percentages of the components, there is but little in the all important flame temperature provided the due proportion of air is concurrently supplied. Along with this fact is the equally important one that rich gas or poor gas alike can be fully utilized, providing the proper apparatus is installed and adjusted. Thus it matters little whether a lamp be installed in Scotland where gas is usually rich, or in Germany where it is often poor, if the air and gas supplies are properly arranged, although the total lighting power will differ, yet the fuel supplied can be almost equally utilized. That is not to say that all town gases are equally good per cubic foot, but the only real difficulty is the one of variation within the same gas supply area. The extent of such variation for London gas is shown in the subjoined table below.

Each group comprises tests for three separate weeks, viz., ending December 15th, 1906, June 6th, 1908, and August 29th, 1908, respectively. The tests are made daily in fourteen stations in the district of the first named, six of the second company, and two of the third. The table has been compiled by the writer from the official returns of the gas examiners, who work according to methods formulated by the Gas Referees. The No. 2 Metropolitan Burner, the 10 candle pentane standard, and the Boy's calorimeter, used in the determination of the quality of London gas, are reliable instruments for their several purposes, and the results are entitled to the greatest respect. Those for the illuminating power may perhaps be thought to be without significance for incandescent lighting, but that is not wholly so. Where the calorific values, gross and net, are given the illuminating power figure falls into a secondary position, but where these are absent, the comparison has to be made on the basis of illuminating power. The last-named is a very sensitive test and where gases of the same genus are being compared it is a quick method of determining a change of smaller magnitude in the calorific values. The three groups represent: first, a mixture

TABLE III.

Name of London Company.	Illuminating power of Gas in No. 2 Metropolitan Burner, per 5 cubic feet of Gas.				Calories (net) Heating Power per cubic foot of Gas at 30 deg. Hg. and 60 deg. Fahr.								Deviation per cent
	Maxima	Minima	Means	Deviation	Averages of the Maxima	Averages of the Minima	Averages of the Means	Deviation	Single Maximum	Single Minimum.	Lowest average	Deviation	
Gaslight	17·16	16·41	16·78	0·37	137·0	132·3	134·6	2·3	145·8	127·5	130·6	3·1	2·3
and Coke	17·36	16·55	16·95	0·40	135·9	129·8	131·6	1·8	136·8	127·1	130·2	3·1	2·3
Company.	17·58	16·63	17·12	0·49	133·2	129·7	131·6	1·9	137·3	124·1	127·9	3·8	2·9
South	16·7	15·63	16·3	0·67	136·1	131·6	133·7	2·1	140·7	128·2	131·1	2·9	2·2
Metropolitan	17·33	16·42	16·93	0·51	134·6	129·96	132·8	2·84	138·0	126·9	127·6	0·7	0·5
Company.	17·18	16·20	16·68	0·48	137·8	131·1	133·9	2·8	149·2	128·2	130·6	2·4	1·8
The	16·0	14·75	15·4	0·65	134·25	125·6	129·05	3·45	134·3	123·5	139·0	5·5	4·2
Commercial	16·41	14·91	15·44	0·53	130·78	126·15	127·95	1·80	133·9	122·8	125·0	2·2	1·7
Company.	15·92	14·91	15·375	0·46	131·6	123·25	127·40	4·15	132·6	121·8	126·7	4·9	3·8

composed of carburetted water gas and coal gas to satisfy a 16 candle Parliamentary standard; secondly, a coal gas only, to satisfy a 14 candle enactment; thirdly, a mixture of water gas and coal gas to satisfy a 14 candle standard.

The figures in the first section of the table show that the deviation in illuminating power, between the minima and means to be small, ranging from 0·37 to 0·67 of a candle. The second section shows a deviation in net calorific value of from 1·8 to 4·15 calories or 7·2 to 16·6 B.Th. Units per cubic foot. These are equal to 1·3 and 3·3 per cent respectively, upon the averages from the testing stations. This appears to be the proper mode of comparison, but if it should be asked what is the greatest deviation over the whole of each of the Company's district, represented not by averages, but by single minima in relation to the average of the lowest returns from the testing stations then that is found in the third section. The percentage of that deviation is given in the fourth section where it varies in the downward direction to the extent of 0·5 for pure coal gas to 4·2 per cent for a mixture. It must not be overlooked that these deviation figures do not take into account the excess quality which at times is given, and which can scarcely be reckoned as a loss to the consumer for his general requirements or as seriously detracting from the economy and uniformity of incandescent gas lighting. The maxima are however given in the table for comparison, and serve to show a direction in which greater uniformity can be secured by the mere avoidance of the excessive margin given by the companies.

In Berlin attention has been given to the maintenance of uniformity in the calorific values of the gas distributed by the Imperial Continental Gas Association. The variations were formerly from 620 to 560 B.Th. units, but since the introduction of Dr. Bueb's vertical retorts the range has been from 560 to 550 gross. Apparently this increase of uniformity has been obtained at the expense of the average quality, and therefore cannot be regarded as satisfactory. There are, however, taking place in England at the present time improvements in technical practice that will secure greater uniformity without degradation of the gas in its manufacture. Such methods of working will redound to the credit and advantage of both the supplier and the user of gas by obviating what is probably an extreme case mentioned by a gas engine maker (see *ante*, pp. 461), and still further increasing the uniformity of the gas where systematically tested as in London.

6. *Temperature of the flame.*—The object of all the arrangements of gas and air supply are to secure the highest possible temperature within and upon the surface of the mantle, and the success of the different types of burner appears to be distinctly in proportion to the extent to which this is realized. It cannot therefore be advisable to minimize the significance of this factor, as unfortunately some authorities have done. Rather is it necessary to see where or how the mistaken, because inexact, view has originated.

The theoretical flame temperature is a calculation that involves the use of the uncertain factors of the rise of specific heat of nitrogen, steam, and carbon dioxide. But after using the best available data there is a doubt as to whether the flame ever reaches the calculated figure, because of the incidence of dissociation at high temperatures. What deduction on this account ought to be made at successive temperatures or for different proportions of the constituents of the products of combustion has not been ascertained. But leaving this out of account, it is important to note within what a comparatively short range the theoretical temperatures lie. The Table IV. gives the absolute

TABLE IV.

Benzene C_6H_6	2090°C	+291°C	=2381°C
Propylene C_3H_6	2095°	+291°	=2386
Ethylene C_2H_4	2134	+291°	=2425
Carbon monoxide CO	2140	+291°	=2431
Methane CH_4	1889	+291°	=2180
Hydrogen H_2	1995	+291°	=2286

scale theoretical flame temperatures adopted by E. St. Claire Deville in calculating the properties of the Paris

gas. The substances are arranged in the order in which they usually occur therein by volume, starting with the one of lowest percentage.

But not only do separate gases thus approximate, but coal gas mixtures made up of these components tend towards an equalization. For instance:

TABLE V.

	Rise of tempera ture above 18°C.	Absolute scale tempera-ture.	Carcels per 1000 calories (net)	Ratios to the lowest tempera-ture carcels.		Rise as temperature function.
1st. Water gas, mean of different experiments	2025°C	2316°C	23·85	1·0358	1·1743	5th power
2nd. Extra rich cannel gas, experiment II. ...	1978	2269	23·22	1·0147	1·1433	8th power
3rd. Very poor coal gas, „ IV. ...	1958	2249	22·86	1·0058	1·1255	12th power
4th. Rich gas, mean of two tests	1953	2244	21·47	1·0036	1·0571	7th power
5th. Poor gas, mean of tests I. and V.	1945	2236	20·31	1·0000	1·0000	Unity

But the fact that these figures are so much alike, is evidence not that flame temperature is insignificant, but that happily it is commercially possible to supply an article that shall furnish the principal desideratum for incandescent gas lighting, viz., a uniformly hot flame. Now from practical working we may draw the conclusion that the hindering of combustion, or dissociation may itself be counterbalanced at least in part, by raising the starting point temperature. In other words, if the air and gas be preheated we obtain in luminous flames and in incandescent mantles an increased effect which appears to correspond to actually hotter flames. Seeing that practical work confirms the expectation as to actual flame temperature I have examined the careful tests of St. Claire Deville as to illuminating results related to theoretical flame temperature, and find these to be also confirmatory.

In the first series a rise of temperature of 86·5° C. increased the carcels per 1,000 calories, 4·295; equal in percentages to 3·87 and 21·13 respectively; and in ratios to 1·0387 and 1·2113 respectively; These results

TABLE VI.

Effect of temperature on luminosity deduced from the experiments of Mr. STE. CLAIRE DEVILLE.

Theoretical flame temperature of gas employed.			Mantles employed.	Carcels per 1000 calories (net basis).	Nature of gas used in test.	No. of tests averaged.
Range.	Mean.	Absolute.				
1943°–1946°	1944°·5	2235°·5	No. 1 and No. 3	20·325	Coal gas	Two
1953°–1986°	1970·8	2261·8	„ and „	21·68	Coal gas and water gas	Six
2002°–2005°	2003·7	2294·7	„ and „	22·87	Ditto	Three
2002°–2023°	2022·7	2313·7	No. 3	23·57	Nearly all water gas.	Three
	2028·0	2319·0	No. 1	24·00	Water gas	One
	2031°·0	2322°·0	No. 3	24·62	Water gas	One
Average of the six sets	2000·1	2291·1		22·844		

TABLE VII.

Theoretical flame temperature of gas employed		Mantle used	Carcels per 1000 calories (net basis)	Nature of gas used in test
Rise above 18° C.	Absolute C			
1978°C	2269	No. 2	23·22	Cannel gas
2001	2292	„	23·67	„ „ and 50% c.w. gas
2013	2304	„	25·16	„ „ „ 75% „ „
2025	2316	„	25·92	Water gas
Average 2004	2295		24·49	

show a rise in luminosity proportional to more than the fifth power of the rise in temperature. In the second series the figures relate to a different mantle, which appears to have yielded 1 to 2 carcels per 1,000 calories more than the No. 1 and No. 3 mantles used in the first series. Here a rise of temperature of 47° C. increased the carcels per 1,000 calories 2·7; equal in percentages to 2·07 and 11·5 respectively; and in ratios 1·0207 and 1·115 respectively; or a rise nearly equal to the sixth power of the temperature function. Stated as a percentage rise per degree the two series are in accord, thus :—

$21 \cdot 13 \div 86^\circ \cdot 5 = 0 \cdot 244 \quad 11 \cdot 5 \div 47^\circ = 0 \cdot 244$

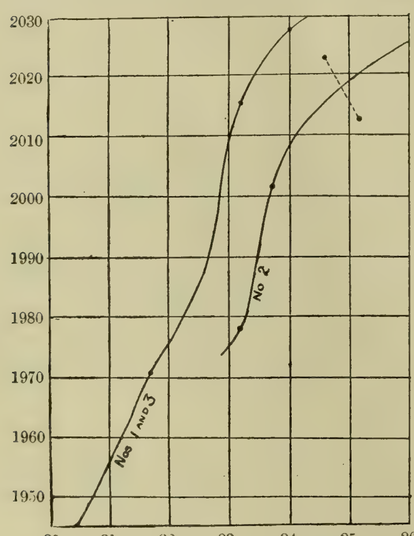

Fig. 2.

Fig. 2 shows the two curves corresponding to the two series of tests. The longer one embodies the approximately equal results when using the mantles numbered 1 and 3, and the shorter one when using No. 2, compared with the theoretical rise of temperature above 18° C. (291° absolute scale).

As these appear to correspond generally with the working results of the various grades of burners, it may reasonably be assumed that the value of a gas is determined by two factors (*a*) the net quantity of heat given out per unit volume, in other words its calorimetric value; (*b*) the relative intensity, roughly indicated by the theoretical temperature of combustion, or its thermometric value. The first acts as directly proportional, and the second acts as to some power—probably not less than the fifth or sixth—of the temperature on the absolute scale.

The various grades of burner referred to above may be classified in the light of the principles enunciated :—

1. The ordinary incandescent burner, with air and gas at normal pressures. Temperature of flame, minimum.
2. The upright or inverted incandescent burner, with air and gas at normal pressures, but preheated. Temperature of flame, above minimum.
3. The upright or inverted incandescent burner, with air and gas at supernormal pressure, obtaining greater proportion of primary air, and consequent higher flame temperature.
4. Same as 3, but with the addition of preheated, primary air, gas, and secondary air to mantle. Flame temperature and radiation of light from mantle highest hitherto attained.

The names of the makers are omitted, but any lamp could be allotted to its own class without difficulty.

A Correction.

[Our attention has been drawn to a regrettable misprint in connexion with the Tables accompanying the last section of Mr. Holgate's article. The two Tables on p. 460 in our July number, referring to Coal-Gas and Water-Gas respectively, were clearly misplaced, and should be interchanged.]

(*To be continued.*)

A Comparison between the Illuminating Efficiencies of Carbon Monoxide and Hydrogen when used in conjunction with the Incandescent Mantle.

By Arthur Forshaw, M.Sc., Institution Research Fellow in the Department of Fuel and Gas Engineering, the University of Leeds.

(Paper read at the Annual Meeting of the Institution of Gas Engineers, London, June 15, 1909; we are indebted to the courtesy of the Council of the Society for permission to publish this paper and to the *Gas World* for the loan of the blocks by which it is accompanied.)

Introduction.

The belief has recently become prevalent that the illuminating efficiency of a combustible gas used in conjunction with an incandescent mantle is proportional to its net calorific value. The basis of this belief seems to be the investigations carried out by Messrs. White, Russell, and Travers in the United States in 1901–2, and, more recently, by M. Sainte-Claire Deville, of Paris, in 1907. The experiments of Messrs. White, Russell, and Travers, which were embodied in a paper read before the Michigan Gas Association in 1902, consisted in a comparison between the net calorific values of various gases and their illuminating efficiencies in conjunction with the incandescent mantle when burnt in an ordinary atmospheric burner properly adjusted so as to give the maximum effect. They concluded :—

1. That no matter what gas was being used with the mantle—whether water gas, coal gas or natural gas —that the point of highest efficiency corresponded also with the point of maximum illumination.

2. That the illuminating efficiency was proportional to the calorific value of the gas approximately in the proportion of 1 candle-power cubic foot for every four calories increase in the net heating value.

An examination of the table of results published with their paper—the essential parts of which, together with an additional column showing the number of calories per candle per hour, which should be a constant, are reproduced below —shows that whereas out of fifteen different gases, ten behaved in a manner consistent with the second of their conclusions, and two others approximately so, three gases—viz., water gas, carbon monoxide, and natural gas—were notable exceptions.

White, Russell and Travers' Tables.

Gas	Net Calorific value	Candles per Cubic Foot	Calories per Candle
Water	60·24	5·53	10·89
Water and coal	108·9	17·5	6·22
Decarburized coal	130 9	21·86	5·99
Coal	144·3	25·4	5·68
Coal and carburetted water	147·86	28·48	5·19
Coal gas and benzolated coal	153 83	27·4	5·61
Benzolated coal	156·1	29·75	5·25
Carburetted water	169·6	32·9	5·15
Carbon monoxide	67·03	5·54	12·10
,, ,, and coal	112·11	20·69	5·42
Hydrogen	62·39	9.67	6·45
Pintsch	239·38	41·63	5·75
Natural	219·28	22·94	9·56
Coal and natural	162·96	25·43	6·41
Coal	140·55	25·60	5·49

M. Sainte-Claire Deville investigated a number of different composite gases, comprising "blue" water gas, coal gas, and various mixtures of the two, whose net calorific values varied between 76·8 and 208·8 calories per cubic foot (water gas to cannel gas). He employed an atmospheric burner specially constructed so that the relative proportions of air and gas in the mixture could be accurately measured. He found that the duty of a given gas (defined as candles per cubic foot per hour when the proportion of air admitted with the gas is so adjusted as to give the highest illuminating effect for the particular rate of gas consumption) invariably increased with the rate of consumption up to a certain maxi-

mum. Beyond this maximum, an increase in the rate of consumption caused no further increase in the duty, which, after remaining constant within a certain limited range of consumption, depending upon the size of the mantle, at length fell off considerably. Taking in each case this maximum duty as the proper basis of comparison with the different gaseous mixtures examined, he concluded that :—

1. The duty obtained for the expenditure of a given number of units of heat per hour remains constant within 15 per cent throughout the whole range of illuminating gas from neat water gas to neat cannel gas.

2. That, therefore, it must be granted that the specific or normal illuminating duty in the incandescent burner is proportional to the calorific value of the gas.

Without questioning the accuracy of M. Sainte-Claire Deville's observations, it seems difficult to attach any physical meaning to the supposed simple connexion between the calorific value of a gas and its illuminating efficiency, whatever view is taken of the cause of luminosity of the mantle. For if it be supposed that the mantle is a "light heat-engine," which in some way emits intense luminous radiations as the result of its being heated in the flame to a high temperature, the proposition that the luminous effect is proportional to the calorific value of the gas (which probably would bear some simple relation to the flame temperature) hardly seems consistent with what is known concerning the relationship between the total amount of radiation emitted by an incandescent solid and its temperature. Or, on the other hand, if it be argued that the luminosity of the mantle is connected with a supposed power of inducing surface combustion —a cause which may at least in part be operative—it must be admitted that its action in this respect will probably be selective with regard to the constituents of a given combustible mixture, and that any such selective action will depend chiefly on chemical factors, and will have no necessary, or even obvious, connexion with the total calorific value of the gas.

It may be observed that, with few exceptions, the comparisons so far made between the illuminating values of various gases and their calorific powers have had reference to more or less complex mixtures of gases, and that the results of such experiments as have been made with single gases, or with mixtures of two gases, are precisely those which do not conform to the conclusions drawn from the more complex cases. This is particularly so with regard to the results obtained by the American investigators. When, therefore, it was suggested to the author, at the time of his appointment to the Gas Fellowship at the University of Leeds, that he should, as part of his work, investigate the question *de novo* from a fundamental standpoint, it seemed desirable that a careful series of comparative experiments should be first of all made with one or two gases in a state of purity, and for this purpose hydrogen and carbon monoxide seemed to possess qualities which eminently fitted them for such a comparison.

In the first place, these two gases are similar in having nearly the same net calorific values—namely, carbon monoxide = 85·9 kg. cent units, and hydrogen = 72·8 kg. cent units per cubic foot at 0°C. and 760 mm.—and also in requiring exactly the same proportion of oxygen (or air) for their complete combustion. But here their similarity ends. They differ in two important respects—namely, in density and in what may be termed, for want of a better phrase, their "combustion intensities." The density of carbon monoxide is fourteen times that of hydrogen (and therefore their relative diffusibilities are as 1 is to 3·74); and not only is the rate of combustion of hydrogen known to be very much higher than that of carbon monoxide, but also their rates are unequally accelerated by the influence of hot surfaces.

It was therefore decided to make a systematic investigation of the mantle efficiencies of these two gases, and the conditions requisite for the attainment of the maximum illumination from

each, with a view to determining whether, with two single gases having nearly the same calorific values, but exhibiting considerable differences in the character of their flames and their modes of combustion, the supposed dependence of illuminating effect upon the calorific values could be verified.

Experimental.

A. *Preparation and Storage of the Gases.* At the outset of the investigation, it was necessary to instal a photometric equipment specially adapted for the investigation of single gases, and one of the first requirements was an arrangement for preparation and storage of the two gases in quantities sufficiently large for continuous and satisfactory working. The hydrogen was prepared by the action of pure dilute sulphuric acid upon the "Crescent" zinc now manufactured by an electrolytic process by Messrs. Brunner, Mond & Co. This brand of zinc has a high degree of purity. It is guaranteed "arsenic free," and contains only traces of carbon, but no sulphur. It is therefore well adapted for the preparation of hydrogen on a large scale. The gas as it was evolved from the generating apparatus, was passed through a series of large wash bottles containing a hot alkaline solution of potassium permanganate, and was then collected over water in a 10 cubic feet gasholder. The gas usually contained between 0·4 and 1·35 (average 0·85) per cent of methane, and had an average net calorific value of 73·9 kg. cent units per cubic foot, as compared with 72·8 for pure hydrogen. As a convenient means of storage, the gas was compressed into iron cylinders at 200 atmospheres pressure; the largest cylinders employed having a capacity of 60 cubic feet of gas at this pressure. In the photometer room, the cylinders of compressed gas were connected with two automatic reducing valves in series, whereby the pressure was reduced down to nearly atmospheric pressure at the point of delivery to the meters leading to the special burners on the photometer bench.

Owing to the exceedingly poisonous character of carbon monoxide, it was not considered safe to store it under high pressure, and therefore other arrangements had to be adopted. The gas was generated by dropping 90 per cent formic acid into hot concentrated sulphuric acid contained in a large round-bottomed flask. To ensure its freedom from acidic impurities, it was passed first of all through a bottle containing a strong solution of caustic soda, and afterwards up a coke tower down which a stream of the same liquid was kept running. The gas was finally collected in a 5 ft. holder over water. Analysis showed that it contained, on an average, between 97 and 98 per cent of carbon monoxide, and had a calorific value of 83·5 kg. cent units, per cubic foot, as compared with 85·9 for the chemically pure gas.

B. *The Photometric Arrangements.* The photometer bench was of the open-bar type, 12 ft. in length, and graduated into centimetres. It was provided with suitable wheeled carriers for the photometer head and for the special burner or burners used during the investigation. The standard of comparison was a Harcourt 10 candle pentane lamp which was fixed to a sliding table resting on the photometer bar. In accordance with the advice of Mr. Charles Carpenter, the pentane standard and the special burner used for the tests were fixed at a distance of 150 centimetres apart for all illuminating powers up to 100 candles. Above this limit it was found necessary to increase the distance to 200 centimetres. The actual tests were always made with the aid of the Simmance-Abady "Flicker" photometer, which was very kindly presented to the department by Messrs. Alexander Wright & Co.

Since it was considered desirable to measure not only the rate of consumption of gas under investigation, but also the proportion of air mixed with it at the burner nipple, arrangements were made for using compressed air from storage cylinders of 60 cubic feet capacity at 200 atmospheres. This air was compressed in the laboratory, and the cylinders were afterwards connected with the meters on the photometer bench through two reducing valves similar to those used in the case of compressed hydrogen. Both gas and

air supplies were passed through suitable meters and governors before delivery to the burners on the photometric bar, and a King's gauge on the gas supply showed the pressure at the injector ripple.

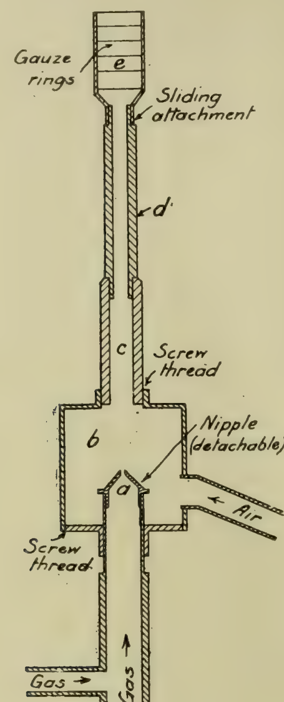

FIG. 1.

C. *Construction of the Burner.* The burner was in its essential parts a copy of M. Sainte-Claire Deville's burner. It is illustrated in Fig. 1. The gas enters by the bottom pipe, and, passing upwards, arrives at the injector nipple *a*, from which it issues into the mixing chamber *b*. For carbon monoxide it is necessary to use a nipple with a larger aperture than for hydrogen. The nipple is therefore detachable, and the air chamber can be unscrewed to give access to it. In the top of the mixing-chamber is placed the ascension pipe *c*. This is provided with a screw-thread, by means of which its height above the nipple can be adjusted. The upper part *d* of the ascension-pipe is of small diameter ($\frac{1}{4}$ in.), to increase the velocity of the upward flowing mixture of gas and air. Finally, the burner head *e*, containing gauze rings, fits the end of *d*. The mantle is held in position by an outside support attached to *d*, and not shown in the illustration. For the making and subsequent modification of the burner, the author is indebted to Messrs. Geo. Bray & Co., who very kindly gave him the advantage of their experience. The burner heads are of two sizes, No. 0 and No. 2, which which were designed to fit the Welsbach mantles No. 0 (50 mm. long by 14 mm. in diameter) and No. 2 (75 mm. long by 25 mm. diameter at the bottom). The Welsbach Company very kindly supplied several dozens of each size of mantle—all made from the same batch of material.

(*To be continued.*)

The Prevention of Sunstroke.

A WRITER in a recent number of the *Military Mail* refers to an experience of Col. F. N. Maude, R.E., C.B., which is interesting in connection with the discussion now proceeding on the effects of ultra-violet rays.

Col. Maude, it is stated, after suffering several times from the effects of a hot sun, eventually came to the conclusion that these attacks were to be ascribed not to the intense heat of the sun at mid-day but to the exceptionally severe ultra-violet element. He therefore made a practice of lining his helmet with orange-red flannel to exclude the actinic rays, and found this plan apparently quite efficacious in preventing a recurrence of sunstroke.

An interesting confirmation of his theory was unwittingly provided by a sceptical young officer who, for a joke, removed the red lining. Shortly afterwards the Colonel was again prostrated while on duty in the hot sun, and was naturally annoyed at this apparent evidence against his theory, until he was subsequently informed by the repentant officer of what he had done

The Protection of the Eyes from Ultraviolet Light.

By Dr. W. Voege.

It will be recalled that in *The Illuminating Engineer* for March of this year a communication from the pen of the author was published replying to the previous communication of Drs. Schanz and Stockhausen on the subject of the effects of ultraviolet light on sunlight. In this article will be found particulars of some further experiments on this point, which have also formed the subject of a recent communication by him to the *Elektrotechnische Zeitschrift* (June 3rd, 1909).

In order to show the absorbing influence of clear glass on ultraviolet rays, a series of spectra are reproduced side by side in Fig. 1. They are as follows :—

(*a*) A Geissler tube filled with hydrogen.

(*b*) A Spark-discharge between zinc electrodes.

(*c*) A Quartz mercury vapour lamp.

(*d*) The same lamp with a clear glass screen 2·8 mm. in thickness in front.

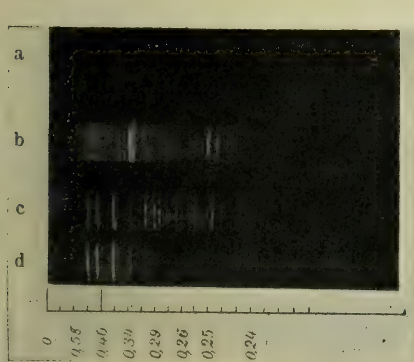

Fig. 1.

It will be seen from Fig. 1 that all rays of lower wave length than 0·3μ are absorbed by the clear glass ; the limit of the visible spectrum is indicated at 0·4μ.

In the same way in Fig. 2 may be seen photographs of the following spectra :—

(*a*) The spectrum of the Quartz mercury lamp unscreened.

(*b*) The spectrum of the lamp, equipped with a clear globe.

(*c*) The spectrum of the lamp within an envelope of clear Jena heavy flint glass.

(*d*) The spectrum of the lamp with yellow Jena screening glass.

(*e*) The spectrum of the lamp seen through nitroso-solution.

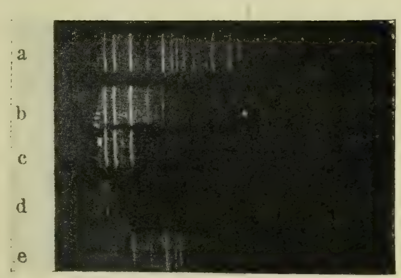

Fig. 2.

From this and other experiments described in his previous communication the author concluded that clear glass is capable of absorbing rays of small wavelength from 0·366μ onwards, and by exposure to sunlight and artificial light of pieces of sensitized paper it was shown that the greatest intensity in the region between 0·366μ and 0·3μ occurred in the case of daylight ; therefore a surface illuminated by any ordinary variety of artificial light would be less open to objection from this point of view than a similar surface illuminated by natural means.

According to Dr. F. Schanz, however, the rays between 0·35μ and 0·4μ are harmful and can exert a direct influence upon the retina. It is, it may be remarked, far from easy to separate rays of this kind from the adjacent

visible spectrum and there is no known variety of screen which will exactly cut off the visible light from the invisible. It may also be pointed out that although Dr. Schanz considers these rays harmful, opinions on this score are very divided. Thus, according to Birch-Hirschfeld, it is not necessary to exclude these rays of comparatively long wavelength. The same observer has described the quartz mercury vapour lamp as harmless to the eyes and adapted for public lighting when hung at the usual height, and equipped with a glass globe.*

According to Prof. Hertel† of Jena, also, the suffering of travellers in snowy regions is to be attributed to the great intensity of visible rays, particularly the yellow-green, which predominate, and the trifling amount of ultraviolet light present exerts practically no influence. The same opinion has been expressed by Dr. Seabrook‡ and Prof. Best. Special reference may perhaps be made to the complete researches of the latter observer who, by a series of different experiments, has disproved many of the assertions of Dr. Schanz. For instance, he has observed the sun at mid-day, in an unclouded sky, through a sheet of uviol glass which, as is well known, absorbs nearly all the visible rays but allows the ultraviolet radiation to pass, for ten seconds without any injury resulting—a performance which would have been impossible to him, even for a fraction of a second, were a yellow glass, which absorbs the ultraviolet but not much of the visible, used.

In connexion with the supposed dangerous qualities of the ultraviolet rays in artificial illuminants the following extract is worthy of special attention :—

"The ultraviolet rays, below $0{\cdot}4\mu$ are, under the ordinary conditions of life, of little consequence in their action on the retina, but an excessive amount of visible radiation may be injurious. The constituent of ultraviolet light in modern sources of light is inconsiderable (excluding the conditions of work in very close proximity to the arclight, &c.). Injuries following working by bright sources of light are the result of their misapplication."

The following recommendations may therefore be laid down and will suffice to protect the eyes both from excessive and visible and ultraviolet radiation.

1. Correct distance from intense sources ; the brightness of surfaces illuminated thereby must not be excessive.
2. The use of adequate screens or indirect illumination.
3. The use of suitable protecting spectacles in certain special cases.

The author has carried out a series of researches on glasses of this nature which, in certain special cases, are undoubtedly necessary. The glasses examined were as follows :—

1. Blue spectacle glass.
2. Enixantos glass.
3. Hallauer glass, including No. 62 bright, No. 64 medium, and No. 66 dark.
4. Yellow Jena protecting glass (Messrs. Schott u. Ge.)
5. Very heavy clear Jena flint glass (Messrs. Schott u. Ge.)
6. Euphos glass.

In addition a number of coloured glasses of various types were examined including deep red, deep green, nickel-glass, and rose, blue and violet.

It is apparent, therefore, that a number of different glasses are available claiming to be effectual in screening the eyes from ultraviolet light. These glasses, however, may profitably be divided into two groups, namely, those of a more or less transparent character which are intended to allow visible light to pass through with little check, and to be used where correct appearance of surrounding objects as regards colour, &c., is essential ; and those of a deep tint which are intended to cut down the visible rays and are intended for such work as is entailed in examining arclights, &c. ; in this latter case the nature of the colour of the glass is seemingly of small consequence.

From glasses of the first kind it is desired that all parts of the spectrum should be equally affected. Naturally

* Ann. d. Elektrotechnik Bd. III., 1908, p. 479.
† E.T.Z., 1908, p. 848.
‡ *Elec. World*, 51, 1908, p. 378.

the thickness of the glass plays an important role. Therefore the author has endeavoured to make a practice of mentioning the thickness of the glass in each case, and has utilized thicknesses similar to those recommended by opticians.

As a means of comparison the spectrum of a Heraeus quartz lamp was used. Spectro-photographs (using quartz lenses and prism) were taken on similar plates through specimens of the various glasses enumerated above; the same exposure (six seconds) was given in each case, and the plates were developed under identical conditions.

In Fig. 3 will be seen some results obtained for the lighter glasses. The exact meaning of the letters attached to the diagram are as follows:—

(*a*) Clear Jena Heavy flint glass, 1·5 mm. thick.

(*b*) Enixantos glass, 1·9 mm. thick.

(*c*) Ordinary clear glass, 2·8 mm. thick.

(*d*) Hallauer glass, No. 62 (bright) 2·3 mm. thick

(*e*) Euphos glass, 1·9 mm. thick.

(*f*) Unscreened spectrum.

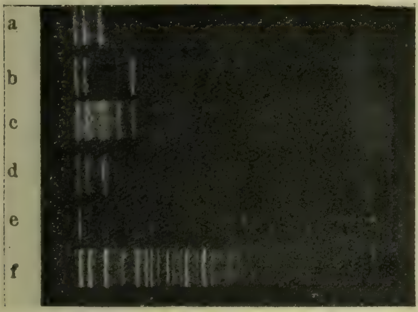

Fig. 3.

Ordinary clear glass (*c*) of ordinary thickness absorbs all rays of smaller wavelength than $0{\cdot}3\mu$; on the other hand the ultraviolet rays of longer wavelength, such as the lines $0{\cdot}366\mu$, $0{\cdot}334\mu$ and $0{\cdot}313\mu$ are transmitted unchecked. The Euphos glass absorbs the ultraviolet rays most completely; it is, however, not quite clear, but distinctly yellow-green in tint. Of the remaining glasses it may be remarked that the colour of the heavy flint and Hallauer specimens was the most satisfactory.

Fig. 4 shows corresponding results obtained for the medium dark glasses, which were as follows:—

(*a*) Blue spectacle glass, 2·0 mm. thick.

(*b*) Euphos glass No. 72, about 1·7 mm. thick (glass for arclamp globes in double thickness).

(*c*) Jena yellow protecting glass, 2·0 mm. thick.

(*d*) Enixantos glass, 1·9 mm. thick.

(*e*) Hallauer glass, No. 64, 2·3 mm. thick.

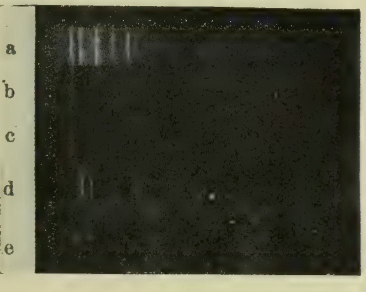

Fig. 4.

As may be seen, the blue glass is quite unadapted to its purpose, but the Euphos, the Hallauer and the Jena yellow glasses are all good.

Finally, Fig. 5 shows the results of testing the darkest glasses in the same way. It must be understood that no very sharp distinction can be drawn between the bright, medium, and dark glasses. Therefore the Enixantos glass is included both in the bright and the medium, and the yellow Jena glass in both the medium and dark glasses. In Fig. 7 the various letters attached to the diagram have the following meaning:—

(*a*) Euphos glass for arclamps, 1 mm. thick.

(*b*) Yellow Jena glass, 2·0 mm. thick.

(*c*) Hallauer glass, No. 66, 2·3 mm. thick.

(*d*) Red glass, 2·3 mm. thick.

(*e*) Red glass, 2·9 mm. thick.

The period of exposure was longer in this case, being increased to twenty seconds. Even so the Euphos glass proved to absorb ultraviolet light very satisfactorily; the yellow Jena glass as in Fig. 4, allows the line 0·366 to be transmitted. The dark Hallauer glass No. 66, and the red glass absorb the ultraviolet light completely, and an even longer exposure led to the same

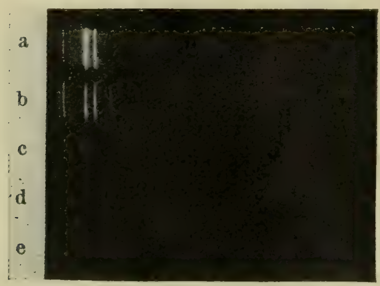

FIG. 5.

result. The ability of deep red glass to absorb the chemically active rays is well recognized and is illustrated by its adoption in photographic dark rooms. On account of its cheapness, and the ease with which it can be procured in large quantities, red glass is particularly to be recommended for use as an observation glass for the study of arclamps, &c. All other varieties of coloured glass are greatly inferior to the red, the blue in particular being quite unsatisfactory and absorbing very little more of the ultraviolet rays than does clear glass.

The author would therefore propose to classify glasses which can be regarded as affording an adequate protection from ultraviolet rays as follows:—

1. *For special work, such as observations of the arc, &c.*

(*a*) Ruby red glass.

(*b*) Dark Hallauer glass. When this glass is not dark enough a double thickness may be used; or it can be combined with a blue spectacle glass.

2. *For work in connexion with the less bright intense sources (glowlamps, mercury vapour lamps, &c.)*

(*a*) Euphos glass.

(*b*) Hallauer glass, medium No. 64.

(*c*) Jena yellow glass.

3. *For work in which light that is specially rich in ultraviolet light is used, but where, nevertheless, the clear perception of detail and of colour-differences is needed* (e.g., *photographic work, bleaching coloured material, &c.)*

(*a*) Clear Jena heavy flint glass.

(*b*) Hallauer glass No. 62.

(*c*) Euphos glass, in quite thin plates.

The Detection of Ultra-Violet Rays.

IN connexion with Dr. Voege's contribution the following short note is of some interest.

C. Schall (*Photograph. Wochenblatt*, p. 33, 1907) described a photo-chemical method of detecting the presence of ultra-violet radiation. A special kind of photochemically sensitive paper is prepared by saturation in a suitable solution of phenylene diamine.

It is stated that such paper is mainly acted upon by ultra-violet rays. Exposure to diffused daylight leads to a pale grey tint, but the rays of a quartz-tube mercury lamp produce a deep blue colouration.

It is also mentioned, however, that a thick plate of ordinary glass acts as an effective screen, which seems to suggest that the rays that are most effective in this way are not those which are believed by Drs. Scharz and Stockhausen to have the most powerful physiological action. These observers, it will be recalled, found that a deep seated action was exercised by rays between 350 $\mu\mu$ and 400 $\mu\mu$, and that these rays were transmitted unchecked by ordinary glass.

The Eyesight of School Children in the City of London.

We have previously often commented upon the important aspect of the lighting of schools, and the recently published report of the Medical Officer for Education to the London County Council, Dr. James Kerr, again contains some interesting figures in this connexion.

Early in the report Dr. Kerr comments upon the ever-widening view which is now taken of the functions of educational authorities. The whole state of provision for aiding the growth and development of a child during the period it is under their care is part of the process of education, and it is inevitable that those who are engaged in teaching should also exercise some supervision on the conditions of the health of those they teach.

The first report of the Medical Officer was published in 1903. Since that time the medical supervision of school children has become much more elaborate. The portion of Dr. Kerr's work with which we are mainly concerned, however, is that connected with vision, and the conditions of illumination in schools; this, it is satisfactory to note, is included in the routine inspection of buildings, which takes place simultaneously with the examination of children.

Figures quoted by Dr. Kerr show that the eyesight of children is still a question for serious consideration, and indeed one of the most difficult with which the medical profession have to cope in their educational work. It is stated that quite 60,000 children in the London schools suffer from defective vision, though the percentages quoted are not so serious as those given by authorities in some other cases. A very complete investigation appears to have been undertaken by Dr. H. Thompson in Woolwich. From April 1st, 1907, to March 31st, 1908, about 14,000 out of 160,000 boys, and about 20,000 out of approximately the same number of girls, were returned by the teacher as possessing bad eyesight in provided schools. Similar figures are given for non-provided schools.

The examination of training colleges, however, seems to have led to considerably higher figures, as perhaps might be expected from the greater age of these pupils. In one case as many as 80 out of 320 pupils examined were proved to have defective vision, and in another case 123 out of 321. The figures given for different colleges, however, seem to vary very widely.

In discussing the reason for such defects Dr. Kerr comments upon the fact that it is only of recent years that many data bearing on this point have been accumulated in this country, and the ideas of opthalmic surgeons are therefore largely based on the work of Continental specialists. There seems, however, to be a general recognition of the need for great care in determining the kind of work to be done by small children; special reference is made to the influence of special work, such as sewing, and this appears to be partly responsible for the fact that a larger percentage of short-sighted girls than boys often seems to exist. Apart from the injurious effect on the eyes of such work, Dr. L. Woodcock draws attention to the effect of such strain on nervous habits and its tendency to produce distorted positions of the body, corrugation of foreheads, squinting, &c. It will be recalled that Dr. Brudenell Carter, many years ago, showed how the position of a child at work might be injuriously affected by badly placed lights. Dr. Woodcock refers to a class of twenty-eight children, hemming in a poorly lighted room. A few minutes after beginning, ten were squinting, eleven were knitting their eyebrows, two were standing up to sew, and half-way through the hour four children

exhibited nervous effects. Working under a bad light naturally intensifies the difficulty of such work. It is recommended, however, that in any case stitching and varieties of work in which it is necessary to count the threads should not be undertaken by children under six or seven years of age.

In addition work involved in matching colours and texture with great exactitude (which is done very perfectly in France, and is known there to be very trying to the eyes), is regarded as unsatisfactory in the case of children and it is stated that red colours are irritating, and that shades are preferably restricted to blues and greens. "Artificial light in schools," Dr. Woodcock remarks, "is practically always insufficient for this work." From October to March, she says, no needlework should be allowed after 3 P.M., and during November 15th to February 15th, no needlework should be permitted in the afternoons at all.

It is gratifying to note the opinion although there is still room for improvement, that the hygienic conditions in school rooms are being gradually improved. There is, however, a remarkable difference in the cleanliness of schools in different neighbourhoods, and this, it may be suggested, is not unconnected with the conditions of illumination provided. The conditions of lighting, as studied during the period from April 1st, 1907, to December 31st, 1908, are as follows :—

Schools	Quality of Lighting					
	April 1, 1907, to March 31, 1908			April 1 to December 31, 1908		
Non-Provided Schools	Good	57	65% approx.	Good	18	72% approx.
	Fair	10	11% ,,	Fair	3	12% ,,
	Bad	21	24% ,,	Bad	4	16% ,,
Council Schools	Good	191	73% ,,	Good	237	81% ,,
	Fair	16	6% ,,	Fair	23	8% ,,
	Bad	52	14% ,,	Bad	33	11% ,,

The Intrinsic Brilliancy of Various Illuminants.

(W. E. Barrows, 'Electrical Illuminating Engineering.')

Nature of Source.	Candle-power per sq. inch.
The Moore Tube	0·6
Frosted incandescent lamp... ...	2–5
Candle flame	3–4
Gas flame	3–8
Oil lamp	3 5
Kerosene lamp	4–8
Cooper Hewitt lamp	16·7
Welsbach gas mantle	20–25
Acetylene flame	75–100
Enclosed a.c. arc depending on globe	75–200
Enclosed d.c. arc depending on globe	100–500
Incandescent lamp 4 watts per candle	300
Incandescent lamp 3·5 watts per candle	375
Incandescent lamp 3·1 watts per candle	480
Gem lamp 2·5 watts per candle ...	625
Tantalum lamp 2 watts per candle	750
Nernst lamp (bare)	800–1000
Tungsten lamp 1·25 watts per candle	1000
Sun on the horizon	2000
Flaming arc	5000
Open arc lamp	11000–50000
Open arc crater	200000
Sun 30 above the horizon	500000
Sun at zenith...	600000

The Annual Meeting of the British Acetylene Association.

(Including the Presidential Address of Mr. C. Hoddle.)

The eighth annual general meeting of the members of the British Acetylene Association was held at the Frascati Restaurant, Oxford Street, London, on Wednesday, May 19th, 1909, at 11 o'clock in the forenoon. Mr. C. Hoddle (President) was in the chair, and others present were Mr. J. Petitpierre (Vice-President), Mr. F. S. Thorn (Past President), Mr. H. S. Smith (Treasurer), Mr. L. M. Fox, Mr. L. Wiener, Mr. John Moyes (Members of the Council), Mr. G. W. Leeson, Mr. A. Giton, Mr. A. S. Gibbs, Mr. J. F. Gore, Mr. Albert Hoddle, Mr. A. S. Young, Mr. Clive K. George, Mr. J. H. Ross, Mr. Leon Gaster (*The Illuminating Engineer*), Mr. C. Raggett and Mr. Lacey Downes (Secretary).

The Secretary having read a notice convening the meeting, the President read the financial statement for the current year. The adoption of the accounts presented was then formerly moved and passed by the meeting, and the President proceeded to review the year's work.

He drew attention to the change of the name of the Association, which was now to be the "British Acetylene Association," in accordance with a special resolution passed at an extraordinary general meeting of the Association on July 7th.

As regards the general work of the association, reference was made to several alterations in the existing regulations affecting the installation of generators and their position relative to buildings. Regulation 4, on this matter was modified in order to protect the ordinary public, and yet not to hamper the developments of the industry in other directions, such as welding, &c. In addition it was recommended that Carbide should be stored in the generating house on a slightly raised platform, and the President mentioned that he, for a good many years, had advised clients to raise carbide slightly off the floor so as to prevent any possible leakage owing to its resting on a damp surface. Other alterations in the regulations affected the sellers's guarantee regarding large quantities of carbide in stock.

The President referred with regret to the death of the late Major-General Sir Owen Tudor Burne on February 3rd last. He also mentioned that the distinguished names of Sir W. Ramsay and Major Cooper Key had been added to the list of Honorary Members. Names of several other members were read out.

The President then explained that it was desired to endeavour to extend the influence and sphere of the association, by forming a student branch, and to arrange demonstrations of the advantages of the new processes which were constantly coming forward. He also said that it might be desirable for them to appoint some one to investigate the advantages and disadvantages of rival illuminants—a matter which would be of much assistance to the industry generally.

It was then suggested that two additional members should be added to the Council of the Association, and the names of Mr. Giton and Mr. Lesson, of Manchester, were put forward; these gentlemen were duly elected. The President also referred to the efforts of the Association to assist lecturers and educational scientists to spread the correct knowledge of the qualities of the new illuminants, and instanced several other practical matters which had received their attention.

Presidential Address.*—In this address the President described some experiences of Petrol Air Gas, which he had gathered through personal use. He said: Let me say at once that my remarks refer only to petrol gas as a whole, and not as referring to any particular system or firm. Some

* Some correspondence on this subject will be found on p. 566.

considerable time ago my directors, in common with other people interested in lighting matters, noticed with some concern the statements made in various petrol air gas catalogues, and, what seemed to be more to the point, saw some apparently very successful installations of this gas at exhibitions, &c., so much so that, considering I had some five or six systems of lighting installed at my own residence, I was asked to add yet another, and find out first-hand what advantages, if any, petrol gas had over acetylene. If petrol gas is really good, they said, we, as a lighting firm, must consider adding it to our business. A sum of money was voted for the purpose, a plant was constructed at our works, and fixed in my little laboratory at home. For some time my experiments led me to think that petrol gas was going to be a real competitor, and we seriously considered the question as to how we could run this new form of lighting together with acetylene. We had all the office and show-room staff required, a well-fitted factory, and a good staff of workmen, and there is plenty of room to make a plant without infringing any one's patents.

I must here tell you that, at considerable trouble and expense, we had devised and made at our works a plant which I consider is now in many ways superior to the majority of petrol plants at present on the market. By the time this was fixed at my house it was nearing the autumn of last year, and, as I have stated, all went well until one day early in November, As you will perhaps remember, we had a very sudden and sharp frost, and that did it. I went into my workshop, as I call it, and tried to get a light. I did get a light, or at least I thought so, but not being quite sure I lit the acetylene to look at it, and then I decided I was mistaken. I might say that, up to now, I had pinned my faith to a cold carburetter, thinking this system would lead to less condensation in the main but this had to be given up, as I soon found that petrol absolutely will not vaporize much below freezing point, hence the need for a hot water circulation. Up to now my experiments had been made indoors only, and using a very few lights; in fact, the whole thing was very crude. Now I proceeded to carry them more into what would be the everyday condition of things, if an installation were fixed in a gentleman's private house. I had a larger plant made, fixed a number of burners, laid a main partly down the garden wall and back again, and fixed stop-cocks so that I could burn the gas direct from the plant, or, after making it, pass it round the long main (about 100 feet) at will. I also fixed a pressure gauge, and erected a large, carefully measured gasholder.

I think that any one looking at this diagram, which represents a type of plant on the market to-day, will see at once that it must be more expensive than an acetylene plant.

The President then exhibited a diagram, and described the working of the apparatus.

Look at the numerous delicate working parts it has—hot-air engine, air-pump, hot-water circulation system, carburetter with its delicate float chamber, mercury valves to regulate the air-ways, petrol tank, gas holder, &c.

The thing that troubled me was the great variation in the lights. If six burners were lighted and the tap on burners adjusted correctly, and then two or three more were lighted, there would be a drop in the illuminating power. Why was this? After close attention for some time I found two reasons. One was the impossibility of maintaining a constant mixture of petrol and air, and the other the weight and volume of the gas combined. As to the uneven richness of the gas, if you get a 4 per cent mixture instead of 2 per cent, you can burn the gas all right as long as you do not use too much of it. You must regulate the stop-cock so that the supply is only 5 ft. of gas an hour instead of 6 ft. But if the gas becomes poorer through lighting up other burners you must turn the stop-cocks on a bit. It is all right as long as you only have to turn on the stop-cocks, but when burners are turned down in various parts of the house the gas gets too rich, and one cannot be

watching every burner in order to alter the stop-cock, As soon as even one light is turned down the burners get black through the gas becoming too rich. I inserted a governor at the main, but found it practically useless. The only place it would be useful is at the burner itself.

Petrol air gas would be all right if one always had the same number of burners in use and could ensure a uniform atmosphere. As soon as you get away from those conditions you get into trouble.

Then, again, on account of the great amount of gas required for a given candle power light the mains must be from six to eight times the capacity of those required for acetylene. What this means is, perhaps, only understood by those who have had some experience in fitting a system of pipes into a country mansion. Very great care is often necessary in fixing even the small mains required for acetylene in order to avoid doing injury, particularly if the building is an old one, so that it is quite certain the fixing of the very large mains I have mentioned would often greatly damage a building, and, if done carelessly, permanently injure it.

Cost of upkeep is the crux of the whole question, and it was mainly because of the statement made that petrol gas was 50 per cent cheaper than coal gas and 100 per cent cheaper than acetylene that I first undertook these experiments. I soon found that it was quite right that 1,000 to 1,200 feet of petrol gas could be made from a gallon of petrol, but I was somewhat surprised to find out the enormous consumption of the burners. Whereas with coal gas I could get a good 20 candle-power light with a consumption of 1 to 1¼ cubic feet per hour it required from 6 to 8 cubic feet per hour of petrol gas, and, as you all know, we can get the same candle-power light for about ⅜ cubic feet of acetylene, and this without troublesome mantles, and no hot-air engine eating up half the gas it makes to supply the necessary pumping power and heat for carburetter. I said half the gas it makes. That may be considered an exaggeration, but is it when you remember that to have the light always ready the engine must be kept going continuously, even if only one burner is required, or, for that matter, none at all, because if you let it stop you cannot get a light without considerable trouble.

Instead of the cost being cheaper than coal gas I make it about double as much, taking the cost of petrol at 1*s.* a gallon and coal gas at 3*s.* per 1,000 cubic feet; hence I cannot see where the claim that petrol gas effects 50 per cent. saving comes in. If that could be shown we should all expect petrol gas to have shut up some of the coal gas works, much less acetylene.

In this connexion I may mention that at our board meeting last week figures were placed before us that showed that we had done several hundred pounds' worth more business than we had done in the corresponding month of last year, and also that we had supplied a 240 light plant to replace a petrol plant. I mention this because it is meeting them on their own ground, viz., large installations; I believe that they admit that petrol is not economical, as compared with acetylene, for small ones.

Let me enlarge upon a difficulty I mentioned just now. Unless the engine is kept going all night you have the carburetter to warm the next day, with the result that when you first start your plant you get two or three lights, and have to wait two or three hours before you get the full benefit of the installation. Then how are all these joints to be oiled if the engine is kept going all night? I have not seen any automatic oiling apparatus, but the engine cannot run all night without oil. I suppose the man in charge must come in several times during the night to oil the engine. I can imagine the ordinary gardener having an apparatus like that to look after; it would send him mad. Compare this with the amount of work and trouble entailed in keeping acetylene apparatus in use. It means placing the carbide in water and leaving it to dissolve; the plant does the rest without any further trouble. You cannot say as much for petrol.

I have quite made up my mind that petrol should not be taken up, and I have advised my directors that it could not possibly be expected to be of any use to us. It would only do more harm than good to consider putting plant on the market, and we decided, I think rightly, to let it alone and do all we can to enlighten buyers of lighting plants as to the trouble connected with that system.

As regards danger, I do not think there is much to be said against petrol air gas, but I am not saying anything about the petrol, as we all know the danger attached to that if any is allowed to escape. I keep a fairly large quantity, and it is no uncommon thing to find the can half empty. The great evaporation of petrol in handling is a point people do not note. As you are aware, according to the Budget proposals, there is to be a tax of 3*d.* a gallon on petrol, and the makers put up the price 4*d.* a gallon. Having inquired the reason, we were told that petrol was a very volatile spirit, and as the tax was put on the amount of spirit imported they had to charge 4*d.* because they lost some thousands of gallons in handling it. If that is so, it is obvious that any one using petrol for a system of lighting must lose a good deal that they are not aware of. In the paper which Mr. Bingham read twelve months ago he said that, taking two installations of similar lighting power, petrol air-gas was not cheap compared with acetylene, and it should be borne in mind that petrol is now dearer and —carbide is cheaper.

Another point to be considered in connexion with the petrol air gas plant is the corrosion in the apparatus, and particularly in the mains, which is a very serious matter. We all know what the effect of the atmosphere is even on granite walls, and if you are going to pass that same atmosphere through iron pipes you will have corrosive effects. It is not the gas that will cause this corrosion, but the atmosphere, whatever it may be, wet or dry. If you pass wet atmosphere through a pipe you will get water in it and corrosion will take place. In the carburetter which I made it was no uncommon thing to find water in the bottom, and a great part of that was carried in by the atmosphere.

What is needed is a really experienced engineer to manage the plant, and then all will be well. I could manage it, but I should not like to give my gardener charge of it. On the other hand, he manages my acetylene plant, and I hardly see it from one month's end to another.

I might continue these remarks until this time to-morrow and still have something to say, but having shown, among other considerations, that the cost of the plant and the cost of upkeep of petrol air gas is a great deal higher than that of an acetylene installation, I will conclude by saying that in my opinion petrol air gas in any form will never be a serious competitor to our illuminant.

At the conclusion of the paper a vote of thanks was moved to the Honorary Solicitors, Messrs. Batten, Proffit, and Scott, and the Honorary Auditors, Messrs. Fitzpatrick, Graham, Greenwood & Co. Special acknowledgment was also made of the services of Mr. Lacey Downes, the Secretary of the Association, and of the literary work undertaken under the supervision of Mr. Ragget, Mr. Gatehouse, senior, and Mr. Gatehouse, junior.

Among other matters subsequently discussed it was suggested that, for the benefit of the country members, the meeting should in future take place during the afternoon instead of 11 o'clock in the morning. This suggestion was approved by Mr. Thorn. The Council undertook to bear this desire in mind in arranging time of the next general meeting. Mr. Thorn also agreed with Mr. Hoddle's remarks regarding the formation of a student's section of the Association. He hoped that fitters and welders would become members and attend such demonstrations.

At the conclusion of the evening a special vote of thanks was passed to the President for his interesting paper and the valuable services which he has rendered to the Association.

REVIEWS, ABSTRACTS, AND REPRODUCTIONS.

The Theory of Flame and Incandescent Mantle Luminosity.

By W. H. Fulweiler.

(A paper read at a meeting of the Philadelphia Section of the United States Illuminating Engineering Society, January 15, 1909.)

THE BUNSEN FLAME.

Flames may be divided into three general types. There is the non-luminous Bunsen flame that is used for all heating and the Welsbach burner; the luminous open flame burner of the fishtail or argand type, and the incandescent mantle.

While the open luminous flame was the earliest one in use, yet it is well to consider first the Bunsen flame, because it presents a simpler type and is free from complications.

In this flame, which is formed when a mixture of gas and air burns freely in the atmosphere, there is the following characteristic structure (Fig. 6). There is a small sharply pointed inner cone enclosed by the zone *a b c* surrounded by the less sharply defined outer cone which is enclosed by the invisible zone *a d e c*,

In the inner cone there is the air gas mixture burning in the zone *a b c* to CO-CO_2-H_2 and H_2O diluted with the atmospheric nitrogen brought in with the air. These gases—excluding the nitrogen—form the constituents of the water-gas reaction, which is a normally-burning flame, comes into equilibrium at the temperature of the zone *a b c*, which is about 1550°C.

Haber and Reichert,[1] in investigating this phenomenon, found that the equilibrium constant K for the water gas reaction, namely

$$K = \frac{C_{CO} \times C_{H_2O}}{C_{CO_2} \times C_{H_2}},$$

might be expressed as a function of the temperature as follows:—

$$\log. K = -\frac{2232}{T} - \cdot 08463 \log_{10} T - \cdot 0002203T + 2\cdot 5084.$$

They found that the gases did come into equilibrium in the zone *a b c* between the temperatures observed, namely, 1250° C. and 1550° C.

Using the values of specific heats according to Mallard and Le Chatelier, the temperatures as calculated by the

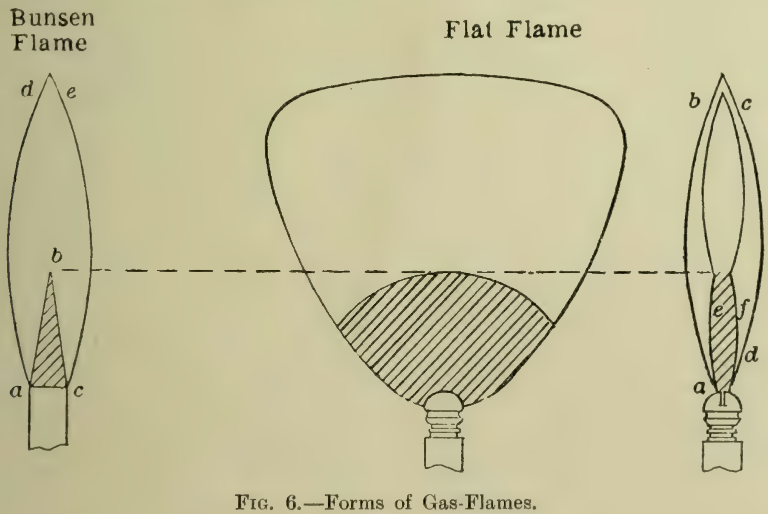

Fig. 6.—Forms of Gas-Flames.

[1] *Zeit. für anorg. Chemie.*, 38, 1904, p. 60.

above formula from the composition of the gases did not vary by more than 10° or 20° from the observed temperatures.

Thus it is seen that the zone *a b c* furnishes a continuous supply of diluted water-gas to the upper cone which, gradually increasing in temperature, burns to CO_2 and H_2O in contact with the atmospheric oxygen in the zone *a d e c*. In this zone the temperature rises according to Féry to from 1710° to 1870° C. Thus there is a mass of glowing gas surrounded by the thin zones where the actual combustions are taking place. This condition is further shown by the fact that oxygen has never been detected in analytical quantities in the upper cone.

The relative positions and colours of the two combustion zones are mutually dependent on the air-gas ratio delivered by the burner tube. The inner cone represents thus a stationary explosion, and the attitude of the inner cone is dependent upon the fact that the velocity of the explosion is slightly less than the velocity of the gases issuing from the burner tube. Thorpe[1] has given some values for the velocity of explosion with different air-coal gas ratios :—

Ratio $\frac{\text{Air}}{\text{Coal Gas}}$	Velocity, Inches per Sec.
6·50	11·4″
6·00	24·2
5·50	32·2
5·25	38·6
5·00	39·7
4·75	36·7
4·33	29·0
3·33	3·8

These facts are plainly shown by the long blue inner cone with a small air-gas ratio and its gradual shortening with increasing air until finally the zone *a b c*, now a bright green in colour, becomes violently agitated, vibrates in and out of the burner tube once or twice, then forms a detonating wave and explodes, usually igniting the jet of gas at the base of the tube. It is now said that the burner has "struck" or "lighted" back. Certain factors, however, may limit or modify this action. If the top of the burner tube be covered with wire gauze or a porcelain button containing a number of small holes, the velocity of the issuing mixture is increased and thus a higher air-gas ratio may be used than with an open tube. Moreover, as the explosion flame approaches the gauze or button, the heat is absorbed so rapidly that the explosion velocity is diminished.

[1] *Jour. of Gas Lighting*, London, July 15, 1877, p. 61.

The colour of the cone, as mentioned before, varies with the air-gas ratio. According to Lewes,[1] with air-coal gas of 2·3 : 1 it is blue changing to a bright green when the ratio reaches 3·4 : 1.

The zone *a b c* is less than a millimetre in thickness and the outer zone *a d e c* must be of the same magnitude. Haber and Reichert calculate that the gas remains in the inner cone about 0·003 second and in the zone *a b c* about 0·001 second. This latter figure is important as showing the velocity of the water-gas reaction.

The temperature of this zone, as before mentioned, has been observed and checked by calculation, from the composition of the gases leaving it, at 1550° C. when the cone was a bright green and the burner was driven hard. Before the recent advances in thermo-electrical measurements the tip of this zone, on account of its bright colour, was considered the hottest portion of the flame. The colour, however, seems to be due entirely to luminescence. Bauer[2] attempted to explain this colour by assuming a very high coefficient of omission for methane present in the glowing zone, but Dr. Lacy[3] working with Haber failed to produce any luminous effect by blowing methane heated by Nernst glowers into a non-luminous benzol flame.

The size and position of the outer cone is determined by the fact that the atmospheric oxygen must burn the water-gas completely to CO_2 and H_2O as it is furnished by the inner zone *a b c*, contracting or expanding to furnish a greater or lesser surface for oxidation as required.

The temperature gradient in the inner cone from the burner tube to the zone *a b c* is very steep, the temperature rising from a few degrees above that of the atmosphere to over 1500° C. with extreme rapidity.

In the upper cone from the zone *a b c* to *a d e c* the rise is more gradual, first on account of the fact that the conduction increases approximately as the square root of the temperature, and second on account of the larger surfaces enclosing the upper cone permitting the rising current of gas to be more quickly heated by conduction. While the zone *a d e c* has the highest temperature—from 1750° to 1870° C.—yet it is so thin and its position is shifting so continuously that one does not ordinarily secure the advantage of its high temperature, and it is

[1] *Jour. of Gas Lighting*, London, May 3, 1892.

[2] Budig's 'Handbuch der angew. physik. Chemie.'

[3] Haber, 'Thermodynamics of Technical Gas Reactions'—Lamb—p. 344.

found that for practical work the body to be heated must be buried quite deeply in the flame.

LUMINOUS FLAMES.

Coming now to the luminous flame, by gradually decreasing the air supply from the bunsen it will be noted that the inner cone elongates and the top of the zone *a b c* disappears. The upper cone first becomes tipped with yellow and the luminosity extends downward toward the inner cone until the flame becomes entirely luminous, when the air supply is completely cut off, and the luminous zone apparently merges into the upper portion of the inner cone. As a matter of fact, it encloses the upper portion of the inner cone, but it is here so thin that its effect is lost. Thus there is obtained the original form of the gas flame.

The early flames were merely small single jets—imitating the candle and not giving much more light. Later, several jets were collected at one burner; these developed into rows and circles, thereby giving the fundamentals of the argand and silt or batswing burners. About 1820 the increase in luminosity that was noted when two of the single jets impinged on one another led to the union jet or fish-tail burner, while about 1854 the principle of recuperation was tried with a double chimney argand burner.

A flat luminous flame appears simple enough, yet there has been an enormous amount of work done on it—much of it misdirected in vain efforts to find facts to fit pet theories.

Sir Humphrey Davy[1] in 1817 gave the first, and, in general, the accepted explanation of the phenomenon. He held that the luminosity was due to hot particles of carbon heated by their own combustion.

Tyndall suggested that the luminous particles need not be burning.

These views were generally accepted until Dr. Frankland[2] began hunting for some recondite reasons. He showed that non-luminous flames could be made luminous by increasing the pressure, and he decided that the luminosity was due to the dense carbon vapours in the flame and it was not carbon particles that caused the luminosity. He showed the effect of atmospheric pressure on luminosity, and found that heavy vapours—such as As_2O_3—would glow brilliantly in a flame. The three factors that influenced the luminosity were: First, the access of oxygen to the flame; second, the velocity of the hydrocarbon vapours; third, the pressure of the atmosphere.

[1] *Proc. Royal Society*, 1817.
[2] *Proc. Royal Institute of Gt. Britain*, 1867.

W. Stein[1] showed that the particles—held by Frankland to be hydrocarbon vapours—were really pure carbon with some occluded gases.

Soret[2] in 1874 followed by Burch[3] and later Stokes[4] examined the flame spectroscopically, and showed that the flame did contain particles of carbon and had some power of reflection that increased with the richer gases of high candle-power.

Knapp[5] showed that loss of luminosity might be caused by neutral gases which could not oxidize the carbon particles.

Wibel[6] held that this result was caused by the lowering of the temperature, and that this was shown by the flame regaining its luminosity by heating.

Barentin[7] and Blochmann[8] showed that this result may have been caused by the expansion in volume in the heated tube opposing such a back pressure to the rising column of gas that the necessary quantity of air was no longer drawn into the tube.

Heumann[9] in 1877 mixed the diluting gas in a holder previous to heating in order to overcome these last objections, and showed that the effect was due entirely to the cooling and diluting effect of the nitrogen of the air, while with pure oxygen the increased activity of the combustion overcame the diluting.

Stein[10] showed, however, that he could decompose coal gas with a flame rendered non-luminous with nitrogen.

Landoldt[11] and Blochmann[12] took up the study and analysis of the gases in the flame, and the preferential theory of combustion was widely discussed.

In the early nineties Lewes[13] brought out his acetylene theory. His claims were:—

1. That the luminosity of hydrocarbon flames is due to the localization of the heat of formation of acetylene, which is formed in the flame, in the carbon and hydrogen produced by its decomposition.
2. That such localization is produced by the rapidity of its decomposition,

[1] *Dingler's Jour.*, 1875, pp. 317-543.
[2] *Phil. Magazine*, vol. xlvii., p. 205.
[3] *Nature*, vol. xxxi., p. 272.
[4] *Proc. Royal Soc.*, Edinburgh, 1878.
[5] *Jour. of Practical Chemistry*, 2, vol. i., p. 425.
[6] *Dingler's Jour.*, 1875, p. 287.
[7] *Pogg. Ann.*, 107, p. 183.
[8] *Jour. für Gasb.*, vol. v., p. 355.
[9] *Jour. für Gasb.*, 1876.
[10] *Dingler's Jour.*, 1874, p. 543.
[11] *Ann. Phys. Chem.*, 94, 1856, p. 389.
[12] *Ann. der Chem. und Pharm.*, 168, p. 295.
[13] *Jour. of Gas Lighting*, London, May 3, 1892; April 16, 1895.

which varies with the temperature of the flame and its composition.

3. That the average temperature otherwise would not be sufficient to produce the incandescence of the carbon particles in the flame.

This theory was in conflict with the work of Armstrong,[1] Haber[2] and Bone[3] on the chemical questions relating to the formation of acetylene, and with the work of Smithells[4] and Thwaite[5] on the physical side relating to flame temperatures.

The work of Smithells[6] showed that the use of ordinary thermo couples did not give nearly high enough indications owing to the rapid conduction of heat along their length, so that it was not certain that the temperatures would not suffice to explain the incandescence of the carbon particles. This question has been cleared to a considerable extent by the work of White and Travers and Haber and Reichert, so that one can now make fairly accurate determinations of flame temperatures by using two couples of different thickness simultaneously.

The late work of Bone and Coward[7] on the decomposition of the hydrocarbons by heat seems to have given a very clear idea of the origin of the carbon particles.

Consider now the probable mechanism of an ordinary open flame. The thin sheet of undiluted gas rises from the top of the burner and immediately commences to expand. The hydrogen, owing to its great diffusive power, and to some extent the methane, rush to the outside of the rising column of gas and are immediately burned, in contact with the atmospheric oxygen, along with a very small percentage of the general constituents of the gas in contact with this burning zone. This fact is shown by the decreasing ratio of H_2O to CO_2 in samples taken at points progressively above the burner.[8] The outer burning zone forms, as it were, an intensely hot envelope for the illuminants in the gas, which from their high specific gravity rise straight up from the burner tip, thereby protecting them from the inrush of oxygen and intensely heating them by conduction.

The general structure of the flame will then be as follows: referring to Fig. 6, there is an inner cone shaded as in the Bunsen burner surrounded on the sides by the zone *e f*, where the bulk of the hydrogen, some methane, and probably carbon monoxide are burning; the remainder of the gas is heated by conduction as it rises straight up between these hot walls. Measurements in this central core of gas show that its temperature increases from about 200° C. just above the tip to over 1100° at the edge of the luminous zone. At this temperature—or say 1200°—as Smithells's measurements were probably in error to that extent—the hydrocarbons are decomposed.

According to Bone and Coward the decomposition takes place by the elimination of the hydrogen and a loosening of the carbon bonds with a formation of HC with three free bonds and H_2C with two free bonds.

These radicals may then act according to the temperature as follows:—

1. Be "hydrogenized," in an atmosphere rich in hydrogen, to methane.
2. Unite to form ethylene or acetylene.
3. Break down into their elements, hydrogen and carbon.

Considering the proximity of the intensely heated zone *a b c d* of complete combustion, which has been shown to have a temperature of about 1800° C., and the fact that at the beginning of the luminous cone the gases have a temperature of 1200°, it seems most probable that the residues follow the third course and break down into their elements, carbon and hydrogen.

Thus there are the necessary carbon particles heated by conduction to a temperature higher than 1200° and approaching 1800° as an upper limit. Bunte has calculated that the carbon continuously present in the incandescent state is about 0·1 milligram.

Lummer and Pringsheim have shown that the limits required—from their study of the energy distribution—were from 1430° to 1630° C., so that the temperature available is quite sufficient to explain the luminosity of the flame. It is, therefore, during the very short interval of time that the carbon particles pass from the central core at say 1300° C. to the outer zone *a b c d* where they burn to CO_2 and H_2O that they are incandescent. Thus it is seen that in the outer zone *a b c d* the same conditions determine its temperature, size, and position as in the bunsen burner before described.

(*To be continued.*)

[1] *Trans. Chem. Soc.*, 49, 1886, p. 74.
[2] *Jour. für Gasb.*, 24, 1896, p. 377.
[3] *Jour. of Gas Lighting*, London, Aug. 4, 1908, p. 319.
[4] *Jour. of Gas Lighting*, London, Jan. 14, 1896 ,p. 78.
[5] *Jour. of Gas Lighting*, London, June 18, 1895.
Jour. Chemical Soc., Dec., 1895.
Jour. of Gas Lighting, London (*loc. cit.*).
Blochmann, *Ann. d. Chem. u. Pharm.*, 168, p. 295.

The Luminous Efficiency of Metallic Filaments.

A VERY important series of researches on the above question was recently published in the *Bulletin of the Bureau of Standards* for February of this year, by W. W. Coblentz. In addition to their significance from the purely scientific standpoint, such results have a very direct bearing upon the performances of incandescent filaments, and the same author in a recent article in *The Electrical World* (Dec. 19th, 1908) has dwelt upon the importance of this connexion.

Much information is furnished by a knowledge of the curves of energy-radiation throughout the spectrum of an illuminant. Incandescent solids, of course, normally yield a continuous spectrum, and a more or less regular curve of energy-distribution, the maximum of which is, however, far outside the visible range, and therefore, as Dr. Drysdale has explained in this journal, the luminous efficiency is correspondingly low. As the temperature of incandescence rises, however, this maximum moves towards the region of small wave-length and the luminous efficiency appears to be improved. All this is well known, and has been expressed in the relation $\lambda_{max}T.=$constant where λ_{max} is the wave-length at which the maximum occurs, and T. the corresponding absolute temperature.

On the other hand, most luminescent gases and vapours exhibit a more irregular distribution of energy, and yield a line-spectrum. They give rise to "selective radiation," and they *may*, therefore, prove more efficient luminous sources than incandescent solids.

Coblentz, however, has shown that many sources usually regarded as falling into the first class, such as certain oxides and flames, show marked traces of selective radiation, and sharp emission bands, which in some cases blend into a continuous spectrum with rising temperature.

The question has therefore been raised how far the efficiency of metallic filament lamps is due to a higher temperature of incandescence. K. Sartori,* for instance, appears to have found that λ_{max} is higher in the case of some metallic filament lamps than in the case of carbon ones, and this suggested that the temperature of the metallic filament might be even *lower* than that of the carbon one. The curves of radiation published by Coblentz and shown in Fig. 1, however, do not seem to agree with this suggestion for the position of λ_{max} is further to the long wave end of the spectrum in the case of the carbon lamp.

The emission of energy from an incandescent solid in general conforms with the Wien equation,

$$E_\lambda = c_1\lambda^{-a}e^{-c_2/\lambda.T.}$$

a formula which Dr. Drysdale has recently discussed in this journal.*

According to Coblentz there are three factors which are mainly instrumental in producing a high luminous efficiency in metallic filament lamps.

1. A high melting point, which enables the filament to be worked at a high temperature, thus causing a shift of λ_{max} towards the violet end of the spectrum, and improving the radiant efficiency.

2. A high emissivity (*i.e.*, "selective emission"), throughout the visible spectrum.

3. A high value of the radiation constant "a," which tends to suppress the useless infra-red radiation of high wave-length.

It appears that in the case of metallic filament lamps all these three effects are of influence. A most interesting characteristic of metals, on which Coblentz lays stress, is that their "reflecting power" is almost invariably high in the infra-red, and correspondingly low in the visible and ultra-violet. Consequently, in accordance with Kirchoff's law, metals emit visible and ultra-violet light with greater ease than a black body, but, on the contrary, are proportionately bad radiators in the infra-red, where the vast bulb of the energy of radiation is usually concentrated. This leads to a gain in radiant efficiency. It seems conceivable too, that on the above grounds there may be reason to expect an exceptionally high intensity in the ultra-violet in the case of lamps using metallic filaments.

* *Elektrotechnik und Maschinenbau*, March 22, 1908.

* *Illuminating Engineer*, April, 1909, p. 232.

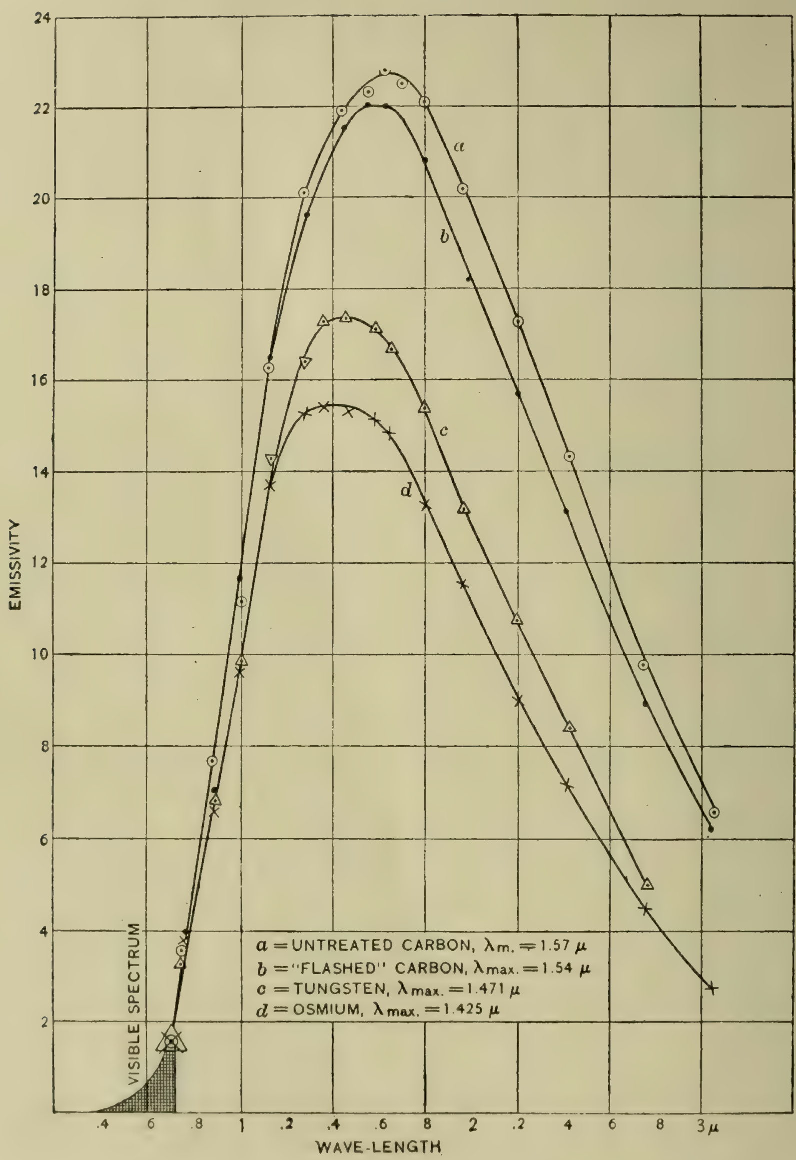

FIG. 1.—Spectral Radiation Curves.
(Coblentz, *Bull. Bureau of Standards*, February, 1909.

Curiously enough this quality on the part of metals is closely connected with their electrical conductivity. Oxides, on the other hand, which are poor conductors were found by Coblentz to possess uniformly high reflecting power in the infra-red. This fact seems to suggest that the inconvenient high conductivity of metallic filaments may, unfortunately, coincide with their good qualities as radiators of luminous energy.

But the constant "a" varies even for the same filament, decreasing with the watts supplied, and with rising temperature just as the electrical conductivity decreases.

This fact, therefore, again serves to improve the luminous efficiency of metallic filaments by decreasing the amount of energy uselessly expended in the infra-red.

The curves in Fig. 1 indicate very

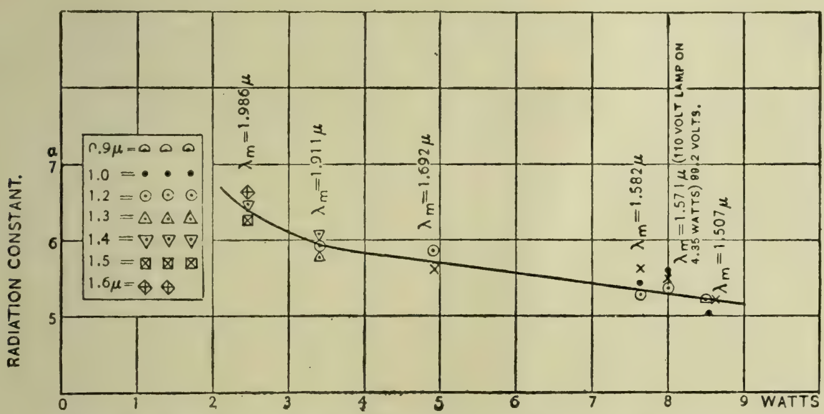

FIG. 2.—Variation of Radiation Constant of Untreated Carbon Filament.

Another interesting quality of metallic filament lamps explained by Coblentz is that the radiation constant "a" is higher than that of a carbon filament, and higher even than that of platinum. Therefore, again, in accordance with (3) above, an improvement in luminous efficiency is secured.

This is shown by the following table :—

clearly how much greater is the amount of infra-red radiation in the case of the carbon filament.

In conclusion the author points out that the results obtained in the case of squirted metallic filaments, consisting of isolated fine particles welded together, cannot be expected to represent exactly the behaviour of rolled stripes of the pure metal.

Radiation-Constants of 110 volt lamps burning normally.

	λ_{max}	$T_{Pt}=\frac{2620}{\lambda_{max}}-273°$	Radiation-Constant "a"
Metallized Carbon	1·423μ	1570° C	6·1
Tantalum	1·344	1670	6·3
Tungsten	1·257	1810	6·6
Osmium (55 volt lamp on 50 volts)	1·401	1600	6·9

Acetylene Lighting for Navigation in the United States.

The well-known invention by Mr. Gustav Dalen to operate automatically acetylene in lighthouses by means of a sun valve (as described in *The Illuminating Engineer*, vol. 1, 1908, p. 905) is, states *The Acetylene Journal*, to be given a trial under the peculiar conditions existing at the beacon on Branford Reef, near New Haven harbour in Long Island Sound, U.S.A.

This is expected to mark a new departure in American lighthouses, and do away with the hundreds of lighthouse keepers along the coast. For years the dangerous hidden reefs at the point stated which only show at low water have been marked by a circular stone day beacon about twenty feet in height surmounted by an iron case or "day-mark." Now it is proposed to install an acetylene light that can be seen for about five or six miles by masters of approaching vessels, the lighting of which at sunset and turning down at sunrise will all be done without human aid for at least a year.

The same journal states that it is anticipated that, at the recommendation of the Californian Lighthouse Commission, the breakwater now in construction at San Pedro will be provided with an acetylene light visible at a distance of six or seven miles.

Reference is also made to some remarks of Mr. Cressy Morison on the lighting of several rivers, including the Lower Mississippi, at present lighted by something like 2,000 oil-lighted beacons, extending over 4,000 miles of river, and controlled by 1,500 light keepers.

On clear nights they can be seen for many miles. They are tended night and morning by light keepers, most of whom are typical darkies of the south, though in the northern rivers there are many white men employed. Sometimes it is a reliable old coloured mammy on whom the government depends. Perhaps the old and grey-haired Uncle Remus, with crutch and cane, derives his sole income from tending a single light. The government pays these men from $6 to $12 a month. Strict account is kept of the oil used, and in this way they are sure that the lamp is turned out in the morning and lighted again each night.

A suggestion was made that these hand-attended oil-lamps might be replaced by automatic acetylene installations — a suggestion which naturally caused some dismay among the light-keepers.

It was subsequently found, however, that the irregular overflow of the river at certain seasons precluded the possibility of establishing permanent acetylene installations.

In some places the river rises upward of fifty feet. When this immense volume of water is thrown from one curve of the river back to the next, it attacks the bank with irresistible force. It literally melts the hardened silt and reduces it to river mud, eating its way into the banks with such rapidity that a change of a mile may take place in a single day.

Lights located where this occurs must be removed quickly or they too will go, and many a faithful light keeper, in his endeavour to save his light has been drawn into the muddy depths and eternity.

Of the 433 lights between Cairo and New Orleans, not more than 90 are permanently located. Many of these lights are lost each year. Over 300 of them must be changed, and some are changed as many as four times in a single year. Without the lighthouse tender and its men, the heavy acetylene cylinders, generator-houses, and all accessories, would be swept away and lost. In all probability, therefore, the present system will be retained for the present.

Acetylene for Village Rifle Ranges.

A recent number of *Acetylene* advocates the use of acetylene lights for village rifle ranges. Such ranges, situated in country districts where gas and electricity are frequently not available, are claimed to be specially good subjects for acetylene lighting, especially as the provision of self-contained portable lights to illuminate targets, &c., is a very important feature.

CORRESPONDENCE.

The Efficiency of Petrol Air Gas Plants.

SIR,—My attention has been drawn to a paper that was read at the annual meeting of the British Acetylene Association by the President, Mr. C. Hoddle, and I would be glad if you could find space for a few critical remarks upon the paper.

In the first place I notice that Mr. Hoddle has chosen to condemn all air gas systems on the results obtained from an admittedly defective plant constructed by himself, quite ignoring, or in ignorance of the fact, that it has taken many years of hard work to construct a plant free from the many defects which Mr. Hoddle admits obtained with his plant.

The President, without any previous experience in this particular field, constructs a plant to produce air-gas, and although this plant was, as he himself admits, a dismal failure, he states that in his opinion it was "superior to the majority of the petrol plants at present on the market"; but how any plant that proved to be absolutely useless in practice can be better than another I cannot understand.

I may say here that I do not hold a brief for the air-gas or petrol gas industry in general, but solely on behalf of the National Air Gas Co., Ltd., to whom Mr. Hoddle's remarks apply more particularly, in view of the fact that to the best of my belief the National System is the only one having an hot water circulation, and which claims to have by its patents a monopoly in thermostatic control — which I assume Mr. Hoddle means when he speaks of mercury valves.

I quite agree with Mr. Hoddle when he states that certain defective results will follow a fall of temperature with a plant that is not constructed on scientific principles, and is deficient in the automatic means by which the defects obtaining with his plant are remedied.

But the failure of his own particular plant does not warrant the rash assertion that all other plants fail likewise; if this were so, the Acetylene industry would not need to be so fearful of the competition of air-gas, or trouble to produce and circulate papers so prejudiced as those of Mr. Bingham and Mr. Hoddle.

The President of the British Acetylene Association falls into the same error as the other writers on the subject of initial outlay, which is immaterial to the question under discussion; the whole proposition resolves itself simply into a matter of lower upkeep with or without superior results. and if the buying public conclude that the better light obtained with air-gas, and the advantages of being able to use it for gas fires and cooking stoves, and other domestic and industrial purposes, with its cleanliness and freedom from smell, non-injurious products of combustion, and the great saving indisputably obtaining with a perfect plant, more than repays the interest on the additional capital outlay, nothing the acetylene people may say, will prevent them paying the higher price.

Mr. Hoddle declaims against the use of incandescent mantles, while other writers interested in the acetylene industry, including Mr. Bingham, prophesy that the successful adaptation of these to acetylene would give infinitely better results than are now obtained by the flat flame burners.

No doubt I am prejudiced in favour of my system, but I would certainly require a lot of convincing that a hot air engine, cast iron and steel, Roots pattern blower, petrol tank, gas holder and circulating hot water, are numerous *delicate* working parts.

I take it by this I am to assume that the gas holder and carbide tank or cylinder of an acetylene plant are also delicate.

The President of the British Acetylene Association is evidently not very much interested in the Budget or he would know that the tax applies only to petrol used for automobile purposes, and not to petrol used for industrial purposes.

It may also interest him to know that the petrol used by the National Air Gas Co., Ltd., costs only 6½*d*., and not 1*s*. per gallon, and I suggest it would be better in future if Mr. Hoddle made some inquiries before rushing into print with such rash statements.

I note that Mr. Hoddle's firm had a larger turnover last month, quite a revival in the acetylene trade, in fact, and displaced a 240 light petrol gas plant (not a National by the way).

Referring to the fact that air gas requires larger pipes than acetylene, the same remarks apply to coal gas, and yet in spite of this great disadvantage, acetylene has not ousted coal gas yet.

I am well aware that with some plants the proportion of vapour in the gas varies with an increase or decrease of consumption, but I can hardly imagine a plant that produced a gas that varied to such an extent that turning one or two burners out caused an enrichment so great that the mantles were carbonized, and if I were Mr. Hoddle I would scrap that plant.

I am very pleased to note he does not intend to place his plant on the market, as there are already too many similar plants, and they do harm to the industry.

The statement that air-gas causes corrosion in the pipes is quite wrong. I saw some pipes recently that had been in use for over two years, and they were like new inside, and I fail to see the comparison between the influence of greased air in iron pipes and the effect of atmosphere on granite.

The loss of petrol in charging a plant or in the production of the gas is all imagination on the part of Mr. Hoddle, but whether or no there is any loss, it is all charged against the efficiency of the plant; 16,000 candle-power hours has to be produced from a gallon of spirit costing 6½*d*., including all loss.

Hot air engines only require oiling once every twenty-four hours, and only a very little oil then, so that Mr. Hoddle need not stretch his imagination to the point of calling out the gardener in the middle of the night.

My company have a number of plants that have been running continuously day and night for the past two years, and the engines are only oiled once in the morning, when the plant receives the only attention necessary for the next twenty-four hours, and this attention is limited to about fifteen minutes, and certainly skilled labour is not necessary, a labourer, or even housemaid can attend to the plant equally as well as a skilled mechanic.

The condensed water which Mr. Hoddle found in his carburettor was due to the faulty construction of his apparatus.

I must admit that Mr. Hoddle's statement that acetylene is not explosive is rather staggering, as I have in front of me at the moment several standard works giving the explosive limits of mixtures of acetylene and air, and according to Grover these range at atmospheric pressure from 4 to 1 to 18 to 1 parts of air to gas, and several authorities give even a wider range, and as Mr. Hoddle's statement is uncorroborated I must keep to my old belief that acetylene is an exceedingly dangerous gas.

The contention that acetylene is non-explosive is simply absurd, as all combustible gases, are in certain proportions explosive, and certainly acetylene is highly explosive within a wide range.

If Mr. Hoddle means the crude gas without any admixture of air, then the same remark applies to petrol and coal gas, as neither of these are explosive without admixture of air.

Referring now to the question of cost, users say it is impossible to produce 1,000 candle-power hours for less than 1*s*. 3*d*., but I will take Mr.

Hoddle's statement that carbide can now be purchased at $1\frac{1}{2}d.$ per pound.

In this week's *Acetylene*—the official journal of the acetylene industry—there is a report upon up-to-date acetylene burners, by an expert favourable to acetylene. The best results that could be obtained from the best burner, and only then with higher pressure than is used in practice, was 40·8 candle-power hours per cubic foot, this works out at 183·60 or say 184 candle-power hours per pound of carbide or approximately $8\frac{1}{4}d.$ per 1,000 candle-power hours as against 1,000 candle-power hours per one half pint of petrol, costing approximately three-eighths of a penny with petrol at $6\frac{1}{2}d.$ per gallon.

If carbide is taken at $3d.$ per pound, the price users have been paying in the past, the cost amounts to $1s.\ 4\frac{1}{2}d.$ per 1,000 candle-power hours, or $1\frac{1}{2}d.$ more than the cost given in air gas companies' pamphlets, in which the comparisons are made with carbide at $3d.$ per pound.

The cost of running the small engine of a 1,000 candle-power hours air gas plant is $1d.$ per twelve hours, and the cost increases proportionately until a 50,000 candle-power hour plant costs $4d.$ for the same period, and this amount has to be written off the efficiency of the system.

Air gas burners last for many years and the mantles with care will last longer than an acetylene burner.

The burners also can be turned down to any extent without affecting the perfect combustion in the least, as the mixture is controlled at the plant, and the whole of the air necessary for complete combustion is passed through the pipes, so that it is quite immaterial whether the burner is turned high or low.

It may interest the President of the British Acetylene Association to know that the paper by Mr. Bingham scattered broadcast by the Association indirectly did my company good.

Air gas is not widely known at present, and the paper brought to the notice of the public the fact that a new gas was on the market, with the result that having made inquiries of the respective merits of air gas versus acetylene the former were successful in obtaining several orders that otherwise would have gone to the acetylene trade.

The acetylene industry are continually making the statement that the particulars of cost, &c., given in the pamphlets of air gas firms are greatly exaggerated, but I would call to their particular notice the fact that the buying public are not so gullible as might be thought, and that gas plants are not sold upon the statements given in a pamphlet, or even by testimonials, my experience being that clients want reference to actual users; it is upon the strength of the replies they place their orders.

In conclusion, I may say the claims made on behalf of air gas are not exaggerated in the way the acetylene industry would have the public believe, and one plant at least is absolutely reliable and capable of producing an uniform gas under all conditions, including excessive and continuous variation of demand, and fluctuations of temperature.

Investigation will prove that even in the heart of London and other large towns both large and small installations of air gas are at work giving every satisfaction, in the works of some of the largest users of coal gas which it has displaced, and in many instances hundreds of men are absolutely dependent on an air gas plant for light and heat.

Plants will also be found in the most isolated districts, not only of this country, but throughout the world, working under the extremes of temperature that may be found in India and Russia, a statement I am prepared to substantiate at any time.

Yours faithfully,

T. H. Glasscoe,

Managing Director, The National Air Gas Co., Ltd.

July 9th, 1909.

DEAR SIR,—I am very much interested in the remarks made by Mr. Hoddle in his Presidential address delivered at the annual meeting of the British Acetylene Association held in May last affording as it does such an excellent example of the truism that "A little knowledge is a dangerous thing."

Years of study have been necessary to master the peculiar features of petrol when applied to lighting, &c. It is not to be wondered at, therefore, that the President obtained such unsatisfactory results when he attempted to manufacture a Petrol gas plant in his private workshop at short notice.

Mr. Hoddle informs us that as soon as his machine was finished, he experienced a very sudden and sharp frost, causing the light to fail. This is exactly what any one thoroughly conversant with the question would have expected from an amateurish plant—amateurishness which is so evident from his succeeding remarks, which state that petrol will not evaporate much below freezing point, hence the need of a hot water circulation.

It is a pity that so much trouble was taken by the worthy President in fixing a long main on the top of his garden wall in order to test for condensation. Surely a far more scientific and withal, simple, operation would have been to have constructed a coil of pipe and have immersed it in a bucket of freezing mixture, when, with a properly constructed apparatus, not the slightest trace of condensation would have been found, even at a temperature many degrees below zero fahr.

The President, in opening his address, stated that his remarks referred to Petrol gas as a whole, and I must therefore take serious objection to his statement as to the delicate working parts of a scientifically designed gas plant. The "De Laitte" plant, for instance, contains no hot air engine, hot water circulating system, delicate float feed carburetter or complicated mercury valves to regulate it. Yet at the present moment nearly 8,000 of these machines are in use, not only in the United Kingdom and the Continent of Europe (not excepting the North or Scandinavia and Russia) but also in countries with such extreme variation of temperature as is the case in the Plains of Northern India during the winter months—tests far more exacting than any that could be obtained by Mr. Hoddle along the top of his garden wall, and yet no condensation takes place.

I was not surprised to learn that another great trouble experienced by the worthy President was the variation he obtained in his lights, and the impossibility of maintaining a constant mixture of petrol and air, difficulties which have been overcome in the "De Laitte" System only after long years of patient and careful calculations and tests.

There is nothing new in the idea of petrol gas for lighting purposes. Any school boy can obtain a light "of sorts" by the aid of a medicine bottle partly filled with spirit, a cork through which two tubes are pased, by the fixing of a burner on the end of one tube, and by blowing with his mouth through the other. I have not had the privilege of inspecting the President's machine, but from the description he gives of the results obtained, one would be led to imagine that it was built somewhat on these lines, a supposition which is strengthened by his subsequent remarks of the poor results obtained in candle-power per cubic foot of gas, instead of 14 candle-power per foot, which he would otherwise have had. I admit that 20 candle-power can be obtained from three-eighths of a foot of acetylene, yet you must not lose sight of the fact that the cost of acetylene gas is, approximately, 30*s*. per 1,000 cubic feet.

What a pity that Mr. Hoddle should have gone to the trouble of enlarging upon the supposed difficulty of keeping an engine running in order to obtain a constant supply of gas, since it is a well-known fact that this motive power was discarded by the principal firm of petrol gas plant manufacturers in this country years ago, so that all that is now necessary to obtain a supply of gas at any moment of the day or night is to turn on the tap.

As regards the absence of danger I am delighted to find that since the last meeting of the Congress this much, if nothing else, has been learnt.

Was the President serious when he mentioned corrosion of the apparatus and in the mains, or is this yet another subtle joke, and does he think for one minute, that in a properly designed generator, wet air is passed into the carburetter? If so, no wonder that he found water in the bottom of his carburetter.

I am, dear Sir,

Yours faithfully,

J. Williams,

Foreign and Colonial Lighting, Ltd.

Dear Sir,—I have read the statements on air gas made by Mr. Hoddle at the annual meeting of the British Acetylene Association, which statements were evidently intended to reassure his hearers as to the likelihood of air gas taking in a great measure the place of acetylene.

Mr. Hoddle states he had a machine constructed which, without infringing any one's patents, was to do the work, but Mr. Hoddle only proved that the machine on which he bases his experience of air gas is a dead failure, and that to arrive at the real facts he would have done well to make his experiments with a machine built on a tried and proved system.

To emphasize this may I draw your attention to the enclosed favourable report written by Mr. Frederick Dye, M.R.I., who has experimented with a machine constructed under my patents, which I enclose for your perusal.

The company that manufactures these machines under my patents claims, and is ready to prove, that quite contrary to Mr. Hoddle's statements, the system is entirely automatic; and that the generation of the gas varies in strict accordance with requirements. The generating machine accommodates itself to the higher or slighter demands without calling for any attention, and no matter how rapid the fluctuation may be, the machine will adapt itself thereto.

The machine generates 1,350 cubic feet of gas from one gallon of petrol. A burner producing 125 candle-power consumes $12\frac{1}{2}$ cubic feet per hour, and petrol at one shilling per gallon brings the cost at approximately five-eights of a penny per 1,000 candle-power hours.

To prove the entire absence of condensation, a main point on which Mr. Hoddle dwells, I carried out the following test before a government representative, the Royal Society of Arts, and in Paris, before a number of leading experts, amongst whom were the engineers of the following French railways:

Chemin de Fer du Nord.

Chemin de Fer de l'Ouest.

Chemin de Fer P. L. M.

Chemin de Fer du Midi.

Gas was passed for three hours through lead pipes in coil, 30 ft. long, $\frac{1}{2}$ in. diameter. This coil was surrounded by a freezing mixture at a temperature of about 20 degrees below Zero C. At the outlet of the pipe a burner was attached, and the light burned steadily all the time, unaffected by the low temperature through which the gas was passing. At the end of the time the pipe was taken out, cut, and no trace of condensation could be found.

The test was carried out under cold carburation, and here I may state that no heating of the petrol ever takes place under my system.

Further, my company made one of the largest air gas installations in this country in the early part of this year, using about 14,000 ft. of piping, 4,000 of which are under the ground; no syphon boxes were placed. I have since disconnected the pipes in various places to satisfy myself as to their internal condition, and I could not discover any trace of condensation, or any effect on the pipes.

Mr. Hoddle says it requires an engineer to attend to the machine, whereas any unskilled person of ordinary common sense can do the

few minutes work required for starting the machine.

He thinks somebody must attend to the machine if it is to be kept running during the night time, whereas nothing of the kind is necessary, lubrication taking place automatically.

I will not dwell on the different great advantages of air gas, such as the non-explosiveness, the absence of offensive smell, and of danger in case of gas escape; nor ought I to ask for more space to point out more of Mr. Hoddle's mistakes. In fact, my excuse for writing at all must be that Mr. Hoddle has thrown down the gauntlet to the whole air gas industry, and I have thought it right to take it up.

I am ready to demonstrate the fallacy of Mr. Hoddle's conclusions, deduced from a worthless machine, and the correctness of my own statements before any competent jury.

Thanking you in anticipation for kindly granting me so much of your valuable space, I beg to remain,

Yours faithfully,

Fred. J. Cox, M.I.Mech.E.

P.S.—The reports which I enclose of such eminent analysts as Mr. Chas. E. Cassal, F.I.C., and Mr. J. Kear Colwell, F.I.C., practically confirming my own statements, may be of interest to you.

July 20th, 1909.

Sir,—Please accept my thanks for giving me a sight of the proofs of the correspondence referring to the paper which I read before the British Acetylene Association.

The attention given to it by the petrol gas industry is somewhat gratifying to me, and to my mind is a proof that the facts given in that paper were sound when viewed from a practical and unbiassed standpoint.

I had no intention of entering into any controversy on this subject. My paper states why I entered on the experiments, and it was at the request of the Acetylene Association I placed on record the results obtained.

My critics' remarks about "a little knowledge....," "amateurishness," &c., are, I think, rather unnecessary. If I am such a novice, how do they account for the undoubted success of the lighting plants which have been manufactured under my patents during the last fifteen years?

It is no difficult matter to answer your correspondents, seeing they are by no means agreed themselves on the main points at issue—what one upholds another condemns.

Mr. Glasscoe candidly admits he holds a brief solely on account of his own company, and that he may be prejudiced in favour of his own system; and I am inclined to think that the views of your other correspondents are influenced by similar considerations.

Mr. Cox states that it is I who have thrown down the gauntlet. On the contrary, I have taken it up on behalf of the acetylene industry in stating the facts I have gathered by using petrol gas under practical conditions, and over a period of many months, not under ideal conditions for three hours using thirty feet of tubing and with *one* burner.

If my machine was a dead failure, unfortunately for the future of petrol lighting, it is by no means an isolated case. My excuse for using a plant of my own design and manufacture must be that I did not desire to investigate the merits or demerits of any particular system, but wanted to find out the possibilities of petrol lighting for the benefit of my company; but what are more convincing to me than my own deductions are the numerous complaints voiced in my company's showrooms almost daily, and received in correspondence, from users of petrol lighting installations.

The 240-light plant mentioned in my paper is only one of many we have recently installed in place of petrol plants.

It is impossible, without trespassing too much on your valuable space, to

answer all the points raised, so I will jest refer to the principal ones.

Mr. Glasscoe falls into the error of supposing that my plant was a dismal failure; on the contrary, in my hands, it was quite a success. It only proved a failure when placed in the hands of a novice to manage; he also falls into the error of supposing acetylenists are afraid of petrol air gas. This is not the case. But we are naturally induced to take our own part by the criticisms levelled against acetylene by representatives of the petrol gas industry.

I have made no mistake on the point of initial outlay. Mr. Glasscoe admits the facts given in my paper. He then, regarding cost of light, tries to make his case good by doubling the cost of carbide and halving the cost of petrol.

I know many users of petrol who would like to buy it at 6½*d*. per gallon delivered, whereas I should like to take Mr. Glasscoe's order for calcium carbide up to any amount at 1½*d*. per lb. delivered.

My remarks about large pipes and variations in light are apparently agreed with.

I may eventually adopt his advice to scrap my plant and put it on the scrap heap with several others, not my make.

Regarding my interest in the budget, I may say I use some hundreds of gallons of petrol annually, and am quite conversant with the proposed tax. I merely called attention to the extra 1*d*. per gallon charged by the importers (which, by the way, is not reclaimable—to say nothing of the trouble which will be involved in claiming back the actual tax paid), to cover loss sustained by them by evaporation.

My remarks about acetylene not being explosive are quite correct and certainly not uncorroborated. Mixtures of air and acetylene or any apparatus producing this are not allowed in this country. On the other hand, with petrol most apparatus produces a mixture of petrol and air which is right in the centre of the explosive range. Then what about crude petrol? Is that safe? Calcium carbide is.

Regarding the candle-power of acetylene burners, the figures quoted by Mr. Glasscoe are from a report on a new burner just introduced by Messrs. Bray & Co., and I must leave them to fight their own battles *re* this report. This much I can say, the figure mentioned by Mr. Glasscoe is far below the efficiency of the "Elta" burner, which is the burner I swear by. To my knowledge there are some thousands of these burners which have been in use over four years and are still in good order. What would Mr. Glasscoe's mantles look like after a like period of use? Then these burners retail at 9*d*. each, against 2*s*. to 6*s*. for petrol gas burners, less mantles.

Referring to the cost of running engine, I am advised the cost is much more than the figures given, but taking his 1*d*. per day for 1,000 candle hours, if this 1*d*. is spent on carbide we get 200 candle hours light per day without any other expense whatever.

I note Mr. Bingham's paper has done Mr. Glasscoe's business good, therefore I am sure he will be pleased to hear it is intended to scatter my paper broadcast in the same manner.

Mr. Cox also falls into the error of supposing my hearers were afraid of petrol air gas, and that I was trying to brighten their last hours of existence. I have given my reasons above for not using a standard plant for my experiments, but if I had carried them out somewhat later, I could have used the plant I mentioned as having been replaced by acetylene. I am afraid the report of my results would then have been even more distasteful.

Mr. Cox's account of his demonstration using 30 feet of piping, a tub of ice and one burner for *3 hours* certainly proves nothing. My garden wall arrangement, although perhaps not scientific, proved much more from a practical standpoint.

His assertion that he can obtain 10 candle hours from a cubic foot of petrol gas is quite modest when compared with Mr. Glasscoe's figures, but I am quite prepared to prove that even

these results are not obtained when the plant is left in the hands of a novice to manage.

Mr. Williams thinks "a little knowledge is a dangerous thing." I agree —particularly as regards *his* knowledge of my plant, and, for that matter, his knowledge of his competitors' plants. I am curious to know how Mr. Glasscoe and Mr. Cox like his assertion that "all the principal petrol air gas plant manufacturers discarded hot air engines years ago."

It is a pity he took so much trouble to explain what "long years" it took to devise a plant, because this rather tends to confirm my statements that a petrol plant is necessarily a delicate and complicated piece of mechanism.

Regarding Mr. Williams's statement of cost, I note he claims 14 candle hours per foot, as against Mr. Cox's 10 candle hours, and I may here state that I am not alone when I say 5 candle hours per foot is nearer the average obtained in practical use.

Mr. Williams requires no hot air engine, but he omits to state that he must use some other cumbersome plant instead, viz., weights lifting tackle or the like, and supply the necessary labour for winding same, or use an hydraulic engine or motor driven by wind. The air under pressure must be supplied somehow.

May I ask Mr. Williams to believe that I was really serious when I mentioned corrosion in apparatus and mains?

In conclusion, like all other things, it will be a case of the survival of the fittest. As Mr. Glasscoe states, the buying public are our judges, and we of the acetylene industry are quite prepared to leave it to them and the future to decide which is best.

I remain, Yours faithfully,

C. Hoddle.

[Mr. Hoddle's paper, to which this correspondence refers, will be found on p. 549.]

Some Publications recently Received.

Electricity for Everybody, by R Borlase Matthews, "a popular handbook dealing with the uses of electricity in home and business." (The Electrical Press, Ltd., 37-38, Strand, and 1, Buckingham Street, London, W.C.)

Ueber Blendung, by Dr. F. Schanz and Dr. K. Stockhausen, (Reprint from Graefe's Archiv für Opthalmologie).—Deals with the dazzling effect of illuminants, and is devoted mainly to further data on the authors' well-known work on the effects of ultra-violet light.

Bulletin of the Bureau of Standards, Washington, U.S.A., May, 1909. Contains an interesting contribution from Mr. H. E. Ives on "A Volt-scale for a Watts-per-candle Meter."

The Electrical Properties of Flame, by Professor H. A. Wilson; Experiments at High Temperatures and Pressures, by G. Matthey, F.R.S., and R. Threlfall, F.R.S.; Tantalum and its Industrial Applications, by Alex. Siemens, M.Inst.C.E. (Papers recently read before the Royal Institution, London.)

The Open Review, July, 1909.—A monthly magazine devoted to the discussion of general problems for the day. Among other articles we note "No Room to Live" dealing with the Housing Problem by J. S. Nettlefold and "A Definition of Socialism," by Belfort Bax. In the "Monthly Notes" we note a reference to the knighthood conferred on Mr. Thomas Matthews, Chief Engineer of Trinity House. In commenting upon the management of the lighting of our shores by the Elder Brethren and officials, however, the writer urges that this department ought to be absolutely under Government Control. With the exception of Turkey, he states, we are the only nation for which this is not the case.

Among other publications received during the month we must acknowledge the following:—*Proceedings of the American Academy of Arts and Sciences, American Chemical Journal, Proceedings of the American Institution of Electrical Engineers, Annales Scientifiques de l'Université de Jassy, Journal of the Röntgen Society, Journal of the Society of Architects, Journal of the Western Society of Engineers, (Chicago), &c.*

TRADE NOTES.

[At the request of many of our readers we are extending the space devoted to Trade Notes, and are open to receive for publication particulars of new developments in lamps, fixtures, and all kinds of apparatus connected with illumination.

The contents of these pages, in which is included information supplied by the makers, will, it is hoped, serve as a guide to recent commercial developments, and we welcome the receipt of all *bona fide* information relating thereto.]

Safe Forms of Electrical Handlamps.

Messrs. Ward & Goldstone (Sampson Works, Salford, Manchester) draw our attention to the "Guardian" hand lamp, specially designed to overcome the danger of exposed metal parts. &c., such as were unfavourably commented upon in the recently issued report of H.M. Inspector of Factories.

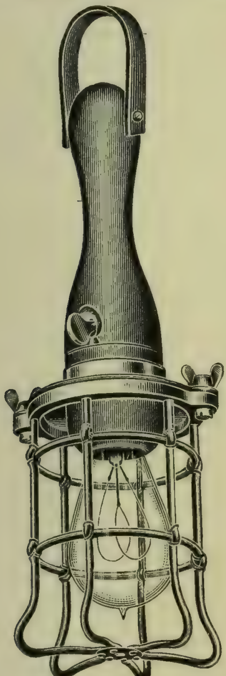

FIG. 1.

In this lamp, it is stated, the lamp holder and cap is entirely enclosed in a strong insulated handle, which provides an effective protection against leakage. In the illustrations two models of the lamp will be noted, one of them provided with a strong galvanized wire guard and switch-holder, the other with an aluminium parabolic reflector, intended for inspection and medical purposes.

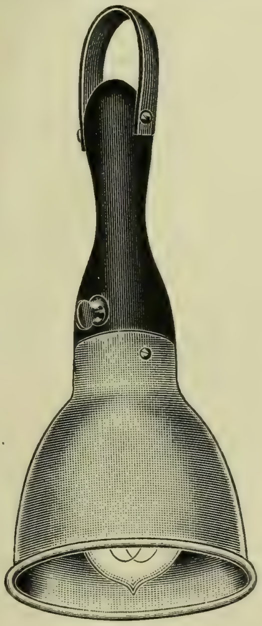

FIG. 2.

The Maximum Light Window Glass Co. (28, Victoria Street, London, S.W.) send us particulars of their ribbed glass for the improvement of daylight illumination in offices, &c., where, owing to the presence of high adjacent buildings, &c., the natural light access is unsatisfactory. This glass is grooved on one side at a certain specified angle in order to refract a considerable amount of the light striking it which would otherwise be lost in the interior of the room.

In some cases roof-treatment is resorted to. In others, perhaps, the lower portion of the windows are provided with ribbed glass and the top portions left clear. The glass, it is stated, may be regarded as an obscuring surface, but at the same time serves to improve the available illumination.

The Dioptric Globe.

The Union Electric Co., Ltd., send us further particulars of the Dioptric Inner Globe which is now fitted with Excello Arc Lamps.

Flame arc lamps with inclined converging carbons have the advantage of throwing almost all their light in a downward direction, the maximum light being projected through the arc at an angle of from 50 degrees to 60 degrees below the horizontal. The illumination thus produced is eminently suitable for shop windows, workshops, factories and similar places where bright lighting effects are needed, and the lamps can be placed at suitable intervals and heights.

The new Inner or Dioptric Globe is formed of a number of prism rings at different angles arranged to bend the rays coming from the intense flame arc in such a way as to secure their most suitable distribution for the desired purpose. In this way, it is claimed, much greater uniformity in illumination is secured. For instance, in one case a maximum of 11 Lux and a minimum of 2 Lux was secured on the stretch of pavement illuminated by lamps 60 yards apart and fitted with Dioptric Globes; *without* this globe, however, the maximum value of the illumination was 21 Lux and the minimum 1·2 Lux.

The Foster Arc Lamp and Engineering Co., Ltd., inform us that they have purchased the goodwill, stock in trade, and all patents, &c., of the Brockie-Pell Arc Lamp Co., Ltd. It is stated, however, that the company will continue to work separately, as regards offices, management, testing, &c., and that all communications relating to Brockie-Pell business should be addressed to that company at Worple Road, Wimbledon, S.W.

The Foster Arc Lamp Co. also send us particulars of their form of Transformer Switch for use with low voltage Metallic Filament Lamps. It is well known that it is not advisable, when the supply-pressure is reduced by means of a transformer, to keep this appliance running continually, on account of its inefficiency at low loads. Switches have therefore been designed to cut out the transformer when not actually needed to supply current to the lamps. The company state that the switches made by them will cut the transformer in and out with current taken by one 10 c.p. metallic filament lamp. The switch is made in two sizes listed at £3 5*s.* and £4 10*s.* respectively.

The Stralsunder Bogenlampen Fabıik send us a copy of their lists of arc lamps for cinematographs and projection, &c., these lamps are made in a wide variety of types, suitable for both direct and alternating currents.

We have also to acknowledge particulars of the **Pope Metallic Filament Lamps,** which are stated to run at an efficiency of 1·25 watts per H.C.P. (British); records are also available of lamps, the life of which are averaged to 1,000 to 2,000 hours.

The Bryant Trading Syndicate, Ltd., recently held the annual outing of their "Metalite" lamps works staff, when about 200 of the girls spent a thoroughly enjoyable day at Brighton. Sports were held during the morning, and some novel and appropriate competitions were introduced, such as the Metalite lamp and spoon race, filament counting race, "potato" race with Metalite lamps instead of potatoes. Numerous and valuable prizes were then distributed to the successful competitors by Mrs. Metcalfe, who in turn was presented with a beautiful bouquet by the staff, and the proceedings closed with a vociferous vote of thanks and three cheers for the Bryant Trading Syndicate.

The First Annual Exhibition of Industrial Chemistry.

The first annual exhibition of the above kind is to be held in the Western Hall of Olympia on October 14th to 23rd of the present year. We understand that many exhibits of interest in connexion with chemical science will be on view, and that a large number of firms connected with industrial chemistry will participate.

All particulars may be obtained from the manager of the Exhibition, the Organizer Publishing and Exhibition Co., Ltd., 2, Bream's Buildings, London, E.C.

Review of the Technical Press.

ILLUMINATION.

There have not been very many items falling under the above heading during the past month, though many of the articles dealing with gas and electric lighting treat upon points that might be so considered.

A number of the contributions deal with STREET LIGHTING the most important being the report issued by the deputation from the Corporation of London which has been touring the Continent with the object of studying existing systems of lighting. As a result of their visit the members of the deputation recommend high pressure incandescent inverted gas lighting, employed in connexion with central standards and lowering gear, though they take no definite decision as yet and contemplate further experiments in the streets of London. This report has been widely commented upon in the gas and electric journals, the former, as a rule, receiving the report very favourably while the latter express dissatisfaction. The lighting of the city of Boston, which decided to employ magnetite lamps in preference to incandescent gas is the subject of a recent editorial in *The Electrical World,* in which some results of experimental tests on these illuminants are given.

Among other contributions dealing with the subject of street lighting attention may be called to the article by **H. T. Owens** in the special Anniversary number of *The American Gaslight Journal* (July 19th), which is well illustrated and pays special attention to the development of street-lighting fixtures and lamp-posts.

An article by **Dr. L. Bloch** deals with the same subject, in *The Illuminating Engineer* of New York (July). The author comments upon some types of fixtures in the United States, utilizing tungsten lamps in diffusing globes, which were illustrated in a previous number of that journal. Dr. Bloch points out that the methods adopted, however ornamental, give rise to a considerable loss of light, and considers the use of globes of this kind quite unnecessary in the streets, though desirable in interior lighting.

Recent numbers of several journals in Germany comment with regret on the fact that the proposals of the Finance Committee regarding the suggested TAX ON ILLUMINATING APPARATUS and gas and electricity have now passed the second reading and are likely to become law, in spite of the wide-spread agitation against them.

PHOTOMETRY.

There have been a number of exceptionally interesting contributions dealing with this subject.

Several German journals contain references to the suggested INTERNATIONAL UNIT OF LIGHT, and the opinion is still expressed that while agreement may be conceded with the relations published, the term "international unit" should not be employed until a proper primary international standard has been obtained; at present it is claimed that the most reliable standard is still the Hefner. The annual report of the Committee on Photometry of the German Institution of Gas Engineers takes this view. This report also states that no decision has yet been agreed upon, regarding the STANDARD METHODS OF TESTING HIGH CANDLE-POWER GAS LAMPS—a matter on which a definite decision is much wanted. The Committee, however, accept the term "Lux" in the sense of the candle-meter, in preference to "Meter-kerze."

W. H. Gartley (*Am. Gaslight Jour.*, Anniversary Number, July 19th), remarks that it is not likely that the nations will want to alter the accepted standards for some time yet, but the question of the *spectrum* of the standard will come up for early consideration.

A reference may also be made to the report of the work of last year, at the Reichstanstalt in Berlin. A number of lamps of all kinds were tested and some experimental work has been done with the flicker photometer. This seems to suggest that differences between individual readers, such as occur with ordinary photometers when comparing heterochromatic sources, are also to be found with the photometer of the flicker type.

A recent article by **Wild** (*Electrician*, July 16), also deals with the flicker

photometer. The author finds that the comparison of a 1·5 watts per candle-power tungsten lamp and a carbon filament lamp does not work out the same when executed with the flicker photometer instead of one depending upon the "equality of brightness," or contrast principle: there is a difference of 6 per cent in the two cases.

Among other articles attention may be drawn to the article by **J. S. Dow** entitled COLOUR AND VISUAL ACUITY (*Elec. World*, N.Y., July 15th), in which the author seeks to distinguish the various items which affect visual acuity, as obtained with light of different colours. An article by **Riedl** (*J. f. G.*, July 24th) describes the use of LIGHT-SENSITIVE PAPERS IN PHOTOMETRICAL EXPERIMENTS. He proposes to compare the darkening of such papers with a standard graded scale of light and shade; the observer, by judging the darkening produced by a given illuminant, can form an idea as to its brightness; but it is pointed out that this method must not be used to compare lamps of different kinds, such as yield different qualities of light.

ELECTRIC LIGHTING.

Several contributions deal with the properties of metallic filaments. **A. Berninger** (*Elek. u. Masch.*, June 27th) deals in a general manner with the properties of TUNGSTEN AND CARBON FILAMENTS, and presents a series of curves connecting candle-power and pressure, &c. He states that a change in candle-power of an ordinary tungsten lamp of 8 per cent is caused by a fluctuation of 1 per cent in the supply pressure: in the case of carbon filament lamps the change in candle-power varies from 12 to 14 per cent, under the same conditions, according to the thickness of the filament.

An article by **Steinmetz** (*Elec. World*, N.Y., July 8th) seeks to establish a connexion between the POWER TAKEN AND THE VOLTAGE OF A TUNGSTEN FILAMENT. He gives the relation, watts$=0·0235.e^{1·6}$ where e represents the impressed voltage, and points out how closely this resembles the hysteresis formula for iron.

Nyswander (*Phys. Rev.*, June) gives the result of some researches on the DISTRIBUTION OF ENERGY IN THE SPECTRUM OF THE TUNGSTEN FILAMENT. The maximum of the energy-curve occurs near $\lambda=1·5\mu$, and the radiant efficiency is stated to be only about 1·5–2 per cent. Even this, however, is about 50 per cent better than would have been the case had the filament been a "black body," and this again is evidence that the filament radiates selectively.

Several articles deal with the recent development of LOW CANDLE-POWER HIGH VOLTAGE GLOW-LAMPS. For instance, the Stearn Co. are stated to be producing a 210 volt 16 candle-power lamp consuming only 25 watts. **Hanchett** refers to the SAGGING EVEN OF SHORT METALLIC FILAMENTS. In spite of this sagging, however, he finds it is often possible to use a lamp in an inclined position; after a certain amount of bending has taken place, it becomes stationary, and, provided the filament does not touch the globe in its new position, it can still burn on.

Among other contributions of a more general character we may note an editorial in *The Electrical Review* of New York (June 26th), in which the importance of the part played by the lighting in promoting the correct "atmosphere" for a theatrical or operatic piece, is emphasized. A general article by **Teichmuller** on the CHOICE OF A SUPPLY PRESSURE (*J. f. G.*, July 17th) is interesting on account of its occurring in a paper devoted to gas interests, and the same holds good for a contribution by **A. F. Ganz** in *The American Gas Light Journal* (July 19th). It is indeed becoming increasingly common for such instances to occur, and it will be noted that, conversely, *The Electrical World* of New York has recently contained several articles on high-pressure gas lighting.

GAS, OIL, ACETYLENE, &c.

The Report of the Deputation, dispatched by the Corporation of London, to study streetlighting, though dealing mainly with gaslighting, is noticed under the heading of Illumination.

A publication of special interest during the past month has been the special number of the *American Gaslight Journal* (July 19) celebrating the fiftieth anniversary of this periodical. This contains a number of articles summarizing the progress of gaslighting and gas manufacture during the last fifty years, which may be commended to those interested in the technicalities of this subject; in the list of references following this review only a few of the items, dealing most intimately with illumination are mentioned; special attention may be drawn to the contributions of **H. T. Owens, W. H. Gartley** and **A. F. Ganz**, which are noticed elsewhere.

Several recent articles in *The Progressive Age* notably those of **C. W. Barnes** and **G. Mclean,** emphasize the value of GOOD RELATIONS BETWEEN THE GAS

COMPANY AND THE CONSUMER, and describe arrangements as regards organization of routine and instruction of staff, &c., by which this state of affairs can be brought about.

Among matters of a more technical and scientific character it may be noted that the study of the connexion between CALORIFIC VALUES and the performances of incandescent gaslamps continues to receive much attention. The recent paper of **Mr. Forshaw,** before the Gas Institute, was very stimulating to discussion on this point and several recent contributions in the columns of the *Gas World* and *Journal of Gaslighting* take up the matter (*e.g.*, editorial notes, *G. W.*, July 3 and July 10, and **T. Holgate,** *G. W.*, July 24).

J. A. Seager (*Illum. Eng.*, N.Y., July) contributes a general article describing the methods of DISTANCE GASLIGHTING in use in England, and illustrating, by a curve of gas-consumption, the saving that can be accomplished by turning lights out automatically at a certain time from the station, instead of by hand.

An article by **A. C. Ware** (*Prog. Age*, July 1) deals with a number of PRACTICAL POINTS IN GAS ILLUMINATION, and led to some interesting discussion. It appears that extremely high illuminations are often used in the United States for shop-lighting, &c., values as high as 70–80 candle-feet being mentioned in this case. Another question of interest was the intrinsic brilliancy of street-illuminants, **H. T. Owens** suggesting that the general public—no doubt unwisely—not only required high illumination, but at present preferred high intrinsic brightness in addition in the streets.

Other illustrated contributions deal with further examples of GASLIGHTING IN BIRMINGHAM (*J. G. L.*, July 13), chiefly from a decorative standpoint, the PHAROS SYSTEM (*J. G. L.*, July 6), and GASLIGHTING IN THE WEST INDIES (*G. W.*. July 24).

Recent numbers of the *Zeitschrift für Beleuchtungswesen* again contain particulars of developments in connexion with mantle design and manufacture.

List of References:—

ILLUMINATION.

Bloch, Dr. L. Street Illumination by Metallic Filament Lamps and Ornamental Lamp Posts (*Illum. Eng.*, N.Y., July).

Editorial. Candle power of Boston Street Lamps (*Elec. Rev.*, N.Y., July).

An Important Report on Street Lighting (*J. G. L.*, July 20; *G. W.*, July 17; *Elec. Rev.*, July 16; *Electrician*, July 16).

The Human Factor in Commercial Illuminating Engineering (*Elec. Rev.*, July 2).

Harris, M. Illumination Cost-Factors (*Elec. Jour.*, June).

Owens, H. T. Fifty Years of Street Lighting in the City of New York (*Am. Gaslight Jour.*, July 19), Fiftieth Anniversary Number.

Smith, E. P. The Lighting Expert as a Decorative Artist (*Illum. Eng.*, N.Y., July).

Stephens, C. E. The Illumination of Streets (*Elec. Jour.*, June).

Report of the Public Lighting of the City of London (*J. G. L.*, July 20; *G. W.*, July 17; *Electrician*, July 16; *Elec. Engineering*, July 22; *Elec. Engineer*, July 16).

The Art of Window Dressing and Lighting (*The Draper*, June 26, July 3, July 17).

Die Besteuerung von Beleuchtungsmittel (*E. T. Z.*, July 8; *Elek. Anz.*, July 18).

PHOTOMETRY.

Cady, W. J. The Photometry of Light-Sources with Reflectors (*Illum. Eng.*, N.Y., July).

Dow, J. S. Colour and Visual Acuity (*Elec. World*, N.Y., July 15).

Editorials. Colour and Visual Acuity (*Elec. World*, N.Y., July 15).

Gartley, W. H. Present Day Photometrical Practice (*Am. Gaslight Jour.*, Anniversary Number, July 19).

Owens, H. T. Handy Formulæ for the McBeth Illumination Calculator (*Am. Gaslight Jour.*, Anniversary Number, July 19).

Riedl. Lichtempfindliches Papier im Dienste der Beleuchtungstechnik (*J. f. G.*, July 24).

Wild, L. The Photometry of Differently Coloured Lamps (*Electrician*, July 16).

Die neue sogenannte internationale Lichteinheit (*E. T. Z.*, June 24, July 8).

Report of Committee on Photometry of the Deutscher Verein von Gas- und Wasserfachmännern (*J. G. L.*, July 13; *J. f. G.*, June 26).

The Work of the Reichsanstalt on Photometry in the year 1909 (*Zeitschr. für Instrumentkunde*, July).

ELECTRIC LIGHTING.

Berninger, A. Ueber Kohlefaden- und Wolframlampen (*Elek. u. Masch.*, June 27).
Editorial. Small Candle Power 200 volt Metal Lamps (*Electrician*, July 2).
Electricity and Stage-Pictures (*Elec. Rev.*, N.Y., June 26).
Power-Characteristics of the Tungsten Filament (*Elec. World*, N.Y., July 8).
Influence of Alternating Currents on Tantalum Filaments (*Elec. World*, N.Y., July 8).
Ganz, A. F. Progress in Electric Current Developments in the Artificial Lighting Field (*Am. Gaslight Jour.*, July 19, 50th Anniversary Number).
Griffin, J. B. Modern Street Illumination by Metallic Flame Arc Lamps (*Illum. Eng.*, N.Y., July).
Hanchett, G. Street Series Tungsten Lamps Burned at any Angle (*Elec. Rev.*, N.Y., June 26).
Murdoch, M. H. Economical Lighting (*Elec. Rev.*, July 2).
Nyswander, R. E. The Distribution of Energy in the Spectrum of the Tungsten Filament (*Phys. Rev.*, June).
Steinmetz, C. P. The Power Characteristics of the Tungsten Filament (*Elec. World*, N.Y., July 8).
Teichmuller, J. Beitrag zur Beantwortung der Frage nach der gunstigsten Betriebsspannung in elektrischen Analagen (*J. f. G.*, July 17).
Vogel, O. Die Wandlungen der Metaldampflampe und der heutige Stand ihrer Entwicklung (*Z. f. B.*, June 30, *concluded*).
Die popularisierung der elektrischen Beleuchtung (*E. T. Z.*, July 1, 1909, 8, 15).
Electric Light and Eyesight (*J. G. L.*, July 6).
Elektrische Tischlampen und Wandarme (*Z. f. B.*, June 30).
A 200 volt, 16 C.P. Metal Filament Lamp (*Elec. Engineering*, July 8).
Street-lighting Fittings (*Elec. Engineering*, July 8).
Street-lighting Fittings (*Elec. Engineer*, July 9).
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GAS, OIL AND ACETYLENE LIGHTING.

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Hewitt, A. Gas Arc Installation and Maintainance (*Prog. Age*, July 15 ; *Am. Gaslight Jour.*, July 5).
Holgate, T. The Mechanics and Physics of the Gas Flame (*G. W.*, July 24).
Humphreys, C. J. R. The Development of the Public Utilities Commissions as Applied to the Gas and Electric Business (*Am. Gaslight Jour.*, July 19, 50th Anniversary number).
Humphrys, N. H. Progress of the Gas Industry of Great Britain during the last Fifty Years (*Am. Gaslight Jour.*, July 19, 50th Anniversary number).
Keillor, J. The Candle-power of Gas in Canada (*Prog. Age*, July 15 ; *Am. Gaslight Jour.*, July 5).
Maclean, G. Mutual Interests of the Gas Company and the Community (*Am. Gaslight Jour.*, July, 12).
Mansfield, A. Design of Atmospheric Burners (*J. G. L.*, July 13 ; *G. W.*, July 6).
Seager, J. A. Distance Control of Gas Streetlighting in England (*Illum. Eng.*, N.Y., July).
Suscipi, L. G. Acetylene for Decorative Churchlighting (*Acetylene Journal*, July).
Todman. The Origin of Progress of Gaslighting (*J. G. L.*, July 6).
Ware, A. C. Comparative Efficiency of Gas Lamps (*Prog. Age*, July).
The Pharos System of High Pressure Gaslighting and High Pressure Airlighting (*J. G. L.*, July 6).
Blau's Liquid Illuminating Gas (*J. G. L.*, July 13).
Birmingham Gas Illumination (*J. G. L.*, July 13).
The Meeting of the Société Technique du Gaz (*G. W.*, July 3 ; *J. G. L.*, June 29).
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On Calorific Power and Calorific Intensity (*G. W.*, July 3).
Gaslighting in the West Indies (*G. W.*, July 24, 1909).
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L'acetylene dans les Colonies Françaises (*Rev. des Eclairages*, July 15).
Rules for the Government of Employees of the Baltimore City Dept. in Charge of lamps and lighting (*Am. Gaslight Jour.*, June 28).
Oil Light Explosions (*Am. Gaslight Jour.*, July 19).
Various Processes connected with the Technicalities of Incandescent Mantle Manufacture (*Z. f. B.*, June 30, July 10).

CONTRACTIONS USED.

E. T. Z.—*Elektrotechnische Zeitschrift.*
Elek. Anz.—*Elektrotechnischer Anzeiger.*
G. W.—*Gas World.*
Illum. Eng., N.Y.—*Illuminating Engineer of New York.*
J. G. L.—*Journal of Gaslighting.*
J. f. G.—*Journal für Gasbeleuchtung und Wasserversorgung.*
Prog. Age.—*Progressive Age.*
Phys. Rev.—*Physical Review.*
Z. f. B.—*Zeitschrift für Beleuchtungswesen*

An Electric Table Cloth.

An electrically wired table cloth, upon which ornamental electric light fixtures diffuse illumination the moment they are set down, is one of the latest and most interesting illuminating devices designed in England. To the uninitiated the

Fig. 1.

ability to get light by simply placing a fixture on the table is nothing less than extraordinary, but the explanation is simple.

The magic table cloth has every appearance of an ordinary baize undercloth, and, in reality, consists of a bottom, cloth of baize, into which are sewn, at regular intervals, strips of metallic braiding alternately connected at one end, the whole terminating in a length of flexible cord which can be attached to a plug in the floor. Upon this undercloth is sewn an upper cloth, specially treated on the under side with a coating of India rubber. Over this is placed an ordinary linen tablecloth and the table is then ready for illumination.

The connexion between the lighting fixtures and the metallic braid is made possible by connectors permanently attached to the bottoms of the fixtures.

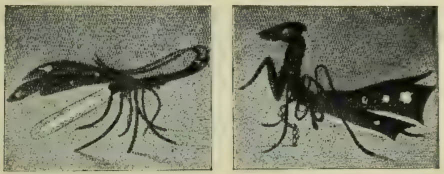

Fig. 2.

These connectors consist of two sharp metallic points, it being only necessary to press the points through the outer linen tablecloth and the upper waterproofed cloth to make the connexion with the electrically-charged braid.

The illustrations show a table thus illuminated, and the type of ornamental fixtures used, many of which are very fantastic. For instance, in Fig. 2 will be seen two quaintly illuminated insects, which derive their light in the above manner, and flowers and fruit are frequently devised on the same principle. (*Popular Mechanics.*)

REVIEWS OF BOOKS.

Repertoire des Industries Gaz et Electrique, 1909.

Maurice Germain, Directeur, Redaction et Administration, 7, Rue Geoffroy-Marie, Paris, Prix, 3 fr.

This volume is devoted to a summary of information relating to the gas and electric industries in France. In the first part of the book both industries are treated simultaneously, full particulars being given of societies dealing with such matters, and alphabetical lists of companies, and engineers, &c., provided. Of special interest is a table in which the gas and electricity supply companies in different districts in France are arranged in column side by side; it is instructive to observe how in some districts electricity seems to prevail to the exclusion of gas and vice versa.

The second and third parts of the book deal respectively in a similar manner with matters connected exclusively with gas or electricity; complete lists are given of the towns in France using one or other of these illuminants.

The book contains much useful information in a handy form, and we think the publication, side by side, of data regarding both gas and electricity is a particularly commendable feature.

PATENT LIST.

COMPLETE SPECIFICATIONS ACCEPTED OR OPEN TO PUBLIC INSPECTION.

I.—ELECTRIC LIGHTING.

12,736/08. Adjustably suspending incandescent lamps. June 13, 1908. Accepted June 23, 1909. C. E. Heldbek, 72, Cannon Street, London.

13,734. Electrodes for lamps, &c (C.S.). I.C. June 27, 1907, Italy. Accepted June 30, 1909. G. Cornaro, 72, Cannon Street, London.

14,483. Mounting and soldering metallic filaments in lamps (C.S.). I.C. July 8, 1907, Italy. Accepted July 14, 1909. S. Marietti, 72, Cannon Street, London.

20,877. Holders and sockets for lamps. October 3, 1908. Accepted July 14, 1909. F. W. Bayliss, 18, Southampton Buildings, London.

23,726. Manufacture of lamp filaments. Nov. 5. 1908. Accepted July 7, 1909. The British Thomson-Houston Co., Ltd., and H. H. Needham, 83, Cannon Street, London.

24,211. Incandescent lamps (C.S.). I.C. Nov. 12, 1907, France. Accepted July 7, 1909. Soc. Française d'Incandescence par le Gaz (Système Auer), 24, Southampton Buildings, London. Addition to 12,720/08.

25,279. Universal joints for electric light fittings. Nov. 24, 1908. Accepted July 14, 1909. C. J. Thursfield, 18, Southampton Buildings, London.

4,122/09. Alternating current arc lamps (C.S.). Feb. 19, 1909. Accepted July 7, 1909. M. Körtung, 24, Southampton Buildings, London.

9,516. Arc lamps (C.S.). April 21, 1909. Accepted July 7, 1909. H. P. Bleckly, Norfolk House, Norfolk Street, Strand, London.

11,579. Arc lamp (C.S.). I.C. June 30, 1908, Germany. B. Duschnitz, 77, Colmore Row, Birmingham.

15,605. Arc lamps (C.S.). I.C. July 6, 1908, Germany. Siemens-Schuckertwerke, G.m.b.H., Caxton House, Westminster.

15,880-1. Arc lamps (C.S.). I.C. May 26, and July 1, 1908. Germany. H. J. J. Jaburg, 37, Furnival Street, Holborn, London. (D.A. March, 29, 1909).

II.—GAS LIGHTING.

7,548/08. Incandescent lamps and burners. April 6, 1908. Accepted July 14, 1909. G. Helps, Izons Croft, Ansley, Atherstone.

13,754. Incandescent lamps. June 29, 1908. Accepted June 23, 1909. E. C. P. Eddrup, H. F. Boughton, and W. H. Everson, 276, High Holborn, London.

14,205. Means for carrying a shade or smoke consumer over an inverted incandescent burner. July 4, 1908. Accepted July 14, 1909. W. Beal, 128, Colmore Row, Birmingham.

24,793. Automatic igniters and extinguishers (C.S.). I.C. June 16, 1908, Germany. M. W. Bröndun, 345, S. John Street, London. Addition to 10,715/08.

27,789. Regulating devices for atmospheric burners (C.S.) I.C. Jan. 28, 1908, Germany. Accepted June 30, 1909. Deutsche Gasglühlicht Akt.-Ges. (Auerges.), 1, Great James Street, Bedford Row, London.

27,948. Anti-vibrator for suspended fittings (C.S.). Dec. 23, 1908. Accepted July 7, 1909. J. S. Weir, 77, Colmore Row, Birmingham.

683/09. Reflectors for gas lamps (C.S.). I.C. March 9, 1908, Germany. Accepted June 30, 1909. J. Hardt, 65, Chancery Lane, London.

5,463. Incandescent mantles (C.S.). March 6, 1908. Accepted June, 30, 1909. L. Severin, 231, Strand, London.

6,963. Attaching mantles to mantle rings (C.S.). I.C. March 28, 1908, Germany. Accepted July 14, 1909. Deutsche Gasglühlicht Akt.-Ges. (Auerges.), 1, Gt. James Street, Bedford Row, London.

7,514. Attaching mantles to mantle rings (C.S.). I.C. June 27, 1908, Germany. E. Skriwan, 1, Great James Street, Bedford Row, London. Addition to 6,963/09.

III.—MISCELLANEOUS.

10,707/08. Lamp globe (C.S.). May 16, 1908. Accepted June 23, 1909. O. A. Mygatt, 322, High Holborn, London.

25,609. Reflectors (C.S.). I.C. Nov. 27 1907, Germany. Accepted June 23, 1909. W. Müller and O. Gaebel, 111, Hatton Garden, London.

EXPLANATORY NOTES.

(C.S.) Application accompanied by a Complete Specification.

(I.C.) Date applied for under the International Convention, being the date of application in the country mentioned.

(D.A.) Divided application : date applied for under Rule 13.

Accepted.—Date of advertisement of acceptance.

In the case of inventions communicated from abroad, the name of the communicator is given after that of the applicant.

Printed copies of accepted Specifications may be obtained at the Patent Office, price 8*d*.

Specifications filed under the International Convention may be inspected at the Patent Office at the expiration of twelve months from the date applied for, whether accepted or not, on payment of the prescribed fee of 1*s*.

N.B.—The titles are abbreviated. This list is not exhaustive, but comprises those Patents which appear to be most closely connected with illumination.

The ELECTRICITY · ACETYLENE · OIL · GAS

ILLUMINATING ENGINEER

Edited by LEON GASTER

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EDITORIAL.

The Progress of the Illuminating Engineering Society.

DURING the past month the work of the organization of the Illuminating Engineering Society in this country has proceeded very satisfactorily.

We are able to state that progress has been steady and continuous, that influential support has been secured from many different professions and countries, and that there is every prospect of the Society opening their session under the most favourable auspices in November next.

It has from the first been decided that the Society should be of an international character, and the support and co-operation of all who have made a study of this subject has been welcomed. During the last month the writer has paid his yearly visit to the Continent so as to be informed of the latest progress in illuminating engineering, and had on this occasion ample opportunities of explaining the objects of the Society and hearing the views of those likely to be interested. During his visit he renewed his acquaintance with many of the chief authorities, at whose hands he received great kindness and consideration; most of these experts are well known to our readers through their contributions in this journal. Many of these gentlemen have kindly agreed to become Vice-Presidents and Corresponding Members of the Society, and all expressed their conviction of the valuable services that a properly organized Society of this kind would render. It was, indeed, generally confessed that on the Continent, as in this country, there are many vexed questions in illumination on which it is very desirable to come to some definite general conclusion, and this could only be done effectively by the concerted efforts of the authorities of different nations. As an illustration of the need for such discussion one has only to turn to the account of the new committee on photometrical matters recently appointed by the *Verband deutscher Elektrotechniker*. The wide scope of the efforts of this committee is made evident by the official record of the matter in the *Elektrotechnische Zeitschrift* for August 5th.

We hope that in the future, as in the past, the services of our collaborators will be found very valuable, and that they will keep us further informed of their experience, and facilitate the much desired co-operation on questions of international importance.

Lighting of the Streets of London.

In our last number we commented upon the report of the Deputation appointed by the Street Committee of the Corporation of London, to investigate the lighting of continental cities.

In the course of the writer's subsequent visit to Germany, he was able to inspect a number of the chief cities, the lighting of which was examined previously by the deputation, and he made a special point of hearing the views of the chief local experts connected with gas and electric lighting as far as time and opportunity permitted. There is, of course, much to be learnt from studying continental practices in street lighting, though the conditions which prevail, and the needs of the people may be different from those in London. Our readers will, for instance, doubtless be interested in the account of the system of slinging high-pressure gas lamps on wires spanning the streets, which prevails in some cities in Germany, and which is shortly described on p. 637 in this journal.

It is interesting to observe that when the report of the deputation was published, this method did not seem to be well known in many quarters, although it was described by Herr Göhrum, the gas engineer of the city of Stuttgart, in the latter part of last year (see *Journal für Gasbeleuchtung*, November 21st, 1908).

What should be borne in mind by the general public, is that the lighting of any city is often largely determined by the peculiar local conditions, and that one must therefore exercise caution in seeking to draw conclusions regarding the illumination of a different city where utterly different conditions prevail. In Berlin, for instance, the fact must not be lost sight of that the municipal authorities own and control the gas lighting, while the electrical company pays the city handsomely for the privilege of exercising its functions. During the last few years very large extensions have been made to the gas-producing plant; additional huge gas-generating plant has been put down at Tegel, near Berlin. The authorities must therefore consider the utilization of the gas they mean to produce. Under these conditions, and bearing in mind the great progress made with high pressure gaslighting systems, it is not, perhaps, surprising that engineers in that city should anticipate that in any event the streets would naturally be lighted by gas, while electricity must rely mostly on private lighting.

In Hamburg, nevertheless, when it was desired to supplement the existing gas-lighting, the authorities preferred to fall back on electric arc lamps in many cases rather than to incur the expense of altering the existing gas system to high pressure, even though the local gas-plant is municipally owned while the electric lighting is done by a private company. The initial cost of installation of arc lamps falls on the private company. All this is mentioned merely to show how easily the general public might be misled in drawing hasty conclusions as to the relative economy of the two methods and attaching too little importance to other special conditions besides the results of photometric tests. Electric lamps, however, are turned out in most streets after midnight, only gas being used for lighting the city from that time onwards.

While one must recognize the existence of such local conditions, it is, however, important that expert testing of street lighting should be undertaken with the object of ascertaining what each illuminant is really capable of doing. The excellent lighting in some parts of Berlin, as pointed out in the last number, is in no small measure due to the care, experiment, and scientific dis-

cussion which the matter has received at the hands of experts like Dr. L. Bloch and Prof. Drehschmidt. At present a set of tests is frequently carried out by a representative of electric lighting with the object of showing that streets are lighted more economically by electricity than gas; at the same time a representative of gas-lighting sets to work to carry out tests, with an exactly opposite desire present in his mind.

Much needless subsequent recrimination might be avoided if only the gas and electric interests would agree to the carrying out of genuine tests, under their joint supervision and for their mutual information. The engineers might then agree as to a common course of action, and arrange for the tests to be carried out by representatives of gas and electric lighting simultaneously, so that the observations and presence of each would act as a check on the other. In Stuttgart, where both gas and electricity are owned by the municipality, and where the final method of illumination to be adopted is still in doubt, a particularly happy state of things in this respect exists. The comparative tests of gas and electric lighting are carried out by the gas and electrical engineers in that city, working together in a perfectly friendly manner. It may be added that during the writer's visit to Germany he found everywhere among lighting engineers the genuine desire for some common basis of agreement regarding the testing of street lighting.

It was openly admitted that the present ideas of what was good and what was bad in street lighting were much vaguer than they need be, and that impartial discussion on the matter, such as the Illuminating Engineering Society might be instrumental in organizing, would be very beneficial, as the views of those residing in different countries could be compared, and some definite compromise arrived at, as a guide for future testings.

It may also be pointed out that, in the case of many cities where the municipality owns neither gas nor electricity, and the question as to which illuminant should be employed is more open, it would be very serviceable to the authorities to have at their disposal reliable information on which to form a judgment as to future developments. The same thing may be said of those cities where *both* gas and electricity are municipally owned. In the case of large and rich cities like London it should be possible to carry out experiments on the necessary scale and to spend money on well-directed researches, if need be, in a manner that small provincial towns cannot afford, and the latter would find reliable results obtained in the metropolis very useful in determining their own decisions. But when the objects of an experiment are vague, and when the results are obscured by innumerable local conditions not apparent to the outside observer, they serve no good purpose and are only misleading to those who wish to draw conclusions therefrom.

Let us at least determine, before embarking on such experiments as it is now proposed to carry out in the City of London, *what exactly it is we wish to learn.*

Street Lighting and the Local Government Board.

We have noticed, in a recent number of *The Electrical Times*, some comment upon the action of the Local Government Board in advising the Finchley District Council to the effect that public gas lighting is preferable to electricity.

Without entering into the question as to how far public lighting ought to fall within the province of the Local Government Board, we quite agree with our contemporary when it is pointed out that advice of this character can only be justified if made with the support of recognized impartial technical advisers whose opinion would carry due weight.

In short, if the Local Government Board contemplate taking action in

this way, we would venture to suggest that the right course to take is to establish an efficient and impartial technical department beyond reproach or bias. At present the lack of any such essential authority is keenly felt, and it may be pointed out that the ceaseless quarrels which take place in connexion with municipal decisions as to the adoption of gas or electricity might come before an impartial tribunal of this kind. It is not suggested that the views of such a central authority should be forced upon those seeking its advice. But it would act as a centre where reliable impartial advice and data could be obtained, and local authorities could either act upon, or, if they cared to undertake the responsibility to the ratepayers, reject the suggestions put before them.

But to be of any value the impartiality and technical standing of such a body must be beyond question, and the conflicting commercial interests must be well balanced.

Tests of Motor Car Headlights.

In a previous number of this journal (July, 1909) we published the regulations issued by the Royal Automobile Club for the testing of headlights of motor vehicles. In the present number we publish, through the courtesy of the Royal Automobile Club, the official account of these tests, which were carried out at the Crystal Palace from July 19th to 21st of this year.

This account ought to form a record of considerable interest and value to motorists and to stimulate manufacturers to contrive forms of lamps which meet the desired conditions. The problem is undoubtedly a difficult one, but in the interest of motorists and pedestrians alike it is most desirable that anything in the nature of objectionable glare should be reduced to a minimum. This test presents yet another instance of the excellent work which the Royal Automobile Club is doing in taking a large and broad view not only of the interests of the motor industry and the motoring public, but also of the standpoint of the vast bulk of the general public who do not ride about in motor cars, and therefore view any inconvenience from their use with a less lenient eye.

We also observe that these tests are carried out with the official approval and request of the Local Government Board. They may, therefore, be said to afford a valuable precedent of governmental interest in matters of illumination. As we never cease to point out, the provision of proper illumination and the wise use of light is a matter of great moment to the nation and one which the Government cannot long neglect.

Stage Lighting.

In another portion of this journal we draw attention to the recently published work by Prof. Biscan dealing with spectacular and stage lighting. This is a subject which offers special opportunities to the illuminating engineer, for there is almost endless scope for mechanical ingenuity in contriving the various special effects of the stage.

It is no exaggeration to say that the psychical effect of a piece may be very largely assisted, or almost irretrievably spoiled, by the selection of ill-advised lighting effects and the choice of a tasteless type of general illumination. An interesting point is also raised by one of our contributors who, in emphasizing the stimulating influence of illumination on imagination, suggested that some places of entertainment may suffer under a somewhat unreasonable imputation of vulgarity largely on account of the glare and lack of taste in the system of illumination employed. However this may be, the importance of good design in the methods of illumination employed in any spectacle which appeals to the eyes can scarcely be over-estimated. One may justly remark that, apart from good staging, charming costumes, &c., lighting effects now form an integral part of any good performance, though there is still much more to be done in this direction.

LEON GASTER.

Review of Contents of this Issue.

In the current number **Mr. A. P. Trotter** (p. 583) gives a short account of the Joly Photometer, employing two translucent blocks as photometric surfaces; he also explains the action and illustrates the appearance of the Abney rotating sector, which is interposed in the path of the beam of light striking one of the photometric surfaces, the angular width of the open sector through which the light passes being adjusted by the observer in order to bring the illumination of both sides of the photometer to equality.

Dr. M. Gaster (p. 586) continues his article dealing with Light in Worship. He shows how the reverence for the sacred nature of fire affects religious ceremony, and gave rise to many modifications in the religious cults of Greece, Rome, and even parts of Ireland. To the illuminating engineer the motives which prompted the lighting up of temples on special festive occasions, &c., are also of special interest.

On p. 589 will be found the official account of the Tests of Motor Car Headlights carried out at the Crystal Palace during the month of July by the Royal Automobile Club, to the courtesy of whom we are indebted for permission to publish these tests in full. The tests were undertaken with the object of investigating the best methods of avoiding glare in head lights of vehicles. A large number of firms exhibited, and the illustrations of some of the lamps shown will be found in this number. This investigation was undertaken at the recommendation of the Board of Trade, and therefore constitutes an interesting precedent as regards governmental recognition of the importance of the subject of illumination.

Following the last article will be found an illustrated review of an interesting work recently published in Vienna, by Lieut. von Benesch. This deals with Methods of Illumination in the Middle Ages, and up to the nineteenth century (p. 600). The writer traces the gradual evolution of these primitive yet often ornamental fixtures up to modern times, and illustrates his remarks by a series of interesting photographs of various antiquated forms of candles, torches, oil lamps, &c. It is pointed out how, at the very time when methods of illumination (regarded from the point of view of light-production) were most inadequate, men were willing to bestow an amount of care and thought on the designs and artistic appearance of lamps and fixtures, which is perhaps less characteristic of many of the more efficient methods of illumination of to-day.

Mr. J. S. Dow (p. 610) refers to some recent experiments on the Photometry of Tungsten Lamps, which suggest that the result of using a Flicker Photometer and a photometer of the equality of brightness or contrast principal may not always be the same. He proceeds to discuss in some detail the theory of the former type of instrument, and brings forward a possible explanation of its action, bearing in mind the theory of the rods and cones on the retina. It is suggested, for example, that the rods in the retina, besides differing from the cones in their general perception of light and colour, may also retain a luminous image, without diminution of intensity, for a longer period.

Mr. Thos. Holgate (p. 615) continues his article dealing with High Duty Gas Lighting. In the present instalment he discusses the calorific values of different qualities of gas, and the bearing of this upon the performances of incandescent gas lamps, illustrating his remarks by various tables and diagrams.

Following this article will be found the continuation of the Report on

THE PUBLIC LIGHTING of streets of London presented by the Deputation which has just returned from abroad after having inspected the lighting of various cities on the Continent; this report was referred to in our last number. The present instalment contains an account of the conditions in Munich, Cologne, Düsseldörf, Dresden, and Vienna.

Dr. C. R. Bohm (p. 628) completes his article dealing with RECENT PROGRESS IN THE MANUFACTURE OF INCANDESCENT MANTLES. In the present instalment he brings to a close his remarks on the various new processes by which artificial silk mantles, yielding light of a suitable colour, and with improved efficiency and durability, can be manufactured.

On p. 631 will be found a review of a recent book dealing with STAGE, SPECTACULAR, AND DECORATIVE ELECTRIC LIGHTING published by Prof. W. Biscan. This discusses many subjects of considerable interest to the present day, including the lighting of public streets on festive occasions, shop lighting, sign lighting, and the application of special methods of light to the stage. In addition to the importance of the main system of lighting adopted in theatres, there is recognized to be a wide scope for ingenuity in devising means of providing the special scenic effects, which many theatrical pieces and operas demand.

Another contributor (p. 635) deals with a similar subject, in an article entitled ILLUMINATION AND IMAGINATION. He, too, points out how the minds of those attending theatrical performances are influenced by the system of lighting adopted; if the latter is of a vulgar and glaring character the audience is apt to draw an unfavourable impression as to the nature of the performance.

Again, on p. 608, will be found a short note relating to some of the side-shows at Earl's Court Exhibition. Many of these, it is pointed out, depend for their success primarily on an appeal through the eye. It is therefore very important to study the convenience of the audience in this respect, and the methods of applying light to the best advantages for spectacular display.

Among other articles in this number attention may also be drawn to several shorter notes of interest. On p. 627 will be found a short account of the so-called "MISSION" FIXTURES for electric lighting which are designed on massive and severe lines, a development of the style originally introduced by the Franciscan monks in California. On p. 637 will also be found a brief account of an attempt to LIGHT BASE-BALL GROUNDS BY NIGHT in the United States, in order that athletics may take place by night as well as by day.

Special attention may also be drawn to the description (p. 639) of the method of SUSPENDING HIGH-PRESSURE INCANDESCENT GAS LAMPS on wires spanning the streets, which has been introduced in Germany, and developed by Messrs. Ehrich & Graetz in Berlin. The account of this system should be of special interest in view of the recommendation of the deputation appointed by the Streets Committee of the Corporation of London that a similar system should be utilized in this country. An illustration of the application of this method in the streets of Stuttgart is also reproduced.

Some notes regarding the advantages of employing several small mantles in a lantern instead of a single long one are also of interest; this renders it possible, for instance, to turn out all but one mantle at night, and thus to save gas, and yet not to plunge the street into complete darkness; in addition small mantles are more durable.

At the end of this number will be found the usual REVIEW OF THE TECHNICAL PRESS (p. 643), and the PATENT LIST (p. 647).

TECHNICAL SECTION.

[*The Editor, while not soliciting contributions, is willing to consider the publication of original articles submitted to him, or letters intended for inclusion in the correspondence columns of 'The Illuminating Engineer.'*

The Editor does not necessarily identify himself with the opinions expressed by his contributors.]

Illumination, Its Distribution and Measurement.

By A. P. Trotter,

Electrical Adviser to the Board of Trade.

(*Continued from p.* 515.)

The Joly Photometer.—One other kind of photometer for ordinary purposes remains to be described. This, the invention of Prof. J. Joly of Dublin,* has been independently proposed by other workers. It consists of two blocks of paraffin wax set side by side. Light falling on the side of a block causes the whole of it to appear to be suffused with light, when the edge is viewed at right angles to the direction of the light. Although a good deal of light passes through the first block, into, and through the second, the optical break of continuity between the blocks is such that the block next to the source of light is much more brilliant than the second one. It is evident that if another light is allowed to fall on the second block, in the opposite direction, a balance may be obtained. The delicacy of this balance depends on the relation between the thickness of the blocks and the amount of illumination falling on them. It depends also on the nature of the material. The wax should be cast in a non-conducting mould, such as a match box, or in a warm metal mould, and should cool slowly. Ample allowance must be made for contraction during solidification. The sides can be finished with a carpenter's plane. A pair of paraffin blocks each 10 mm. thick are not sensitive to the usual illumination of one foot candle or ten metre candles. Blocks each about 5 mm. thick give good results with such illumination, but some workers might think the surfaces are too narrow for convenience.

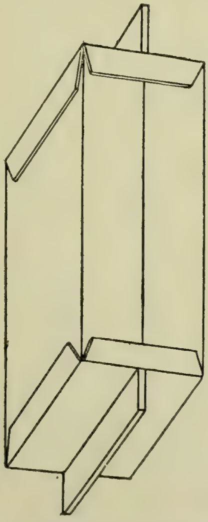


Fig. 88.—The Joly Photometer.

Prof. Joly did not propose any dimen sions for the wax blocks, but he suggested also the use of translucent glass with a sheet of silver foil cemented between the blocks. For these he recommended 20 mm. by 50 mm. by 11 mm., the first dimension being the

* *Phil. Mag.*, July, 1888, vol. xxvi., p. 26.

depth in the direction of view, the second the height, and the third the width of the face of a single block, as seen by the observer.

Photometers consisting of such blocks made by Krüss are used for sorting lamps at the Robertson Lamp Works at Hammersmith.

The opal glass is much more translucent than paraffin wax. When in balance, the blocks appear equally and almost uniformly bright. But on disturbing the balance it is seen that the less brightly illuminated block has a grey band next to the dividing line, and with a rapid reversal of balance this band seems to shift from one block to the other. If an attempt be made to bisect this band by the dividing line a more accurate balance can be effected than by merely trying for equal brightness of the two blocks.

Rotating Sectors.—All the photometers described in these articles, with the exception of the discrimination photometer of Houston and Kennelly, depend on the balancing of two illuminations by adjusting the distances between the photometer head and the lamps to be compared, and relying on the geometrical law of the squares of the distances. Such confidence may be placed in this law, under ordinary conditions, that the graduation of the scales is a matter of simple calculation, and the construction depending on the adjustment of the distances is of so simple a character that it is not likely to be supplanted for ordinary work. But in certain scientific investigations the range of movement is sometimes inconvenient, and other means are adopted for altering the illumination.

Many different devices have been proposed, such as double or "folding" wedges of grey glass; apparatus depending on the thickness of a liquid like diluted ink, or on the use of polarized light; apertures of adjustable size like the "iris" diaphragms used in photography, and so on. Many forms of such apparatus are described by Palaz, while Liebenthal devotes a section of his treatise to methods of weakening the light otherwise than by altering the distance. All these are applicable for scientific investigations, and some of them possess merits for special purposes, but they have not proved to be suitable for industrial photometry of candle-power. Nearly all of them necessitate the use of eye-pieces, and they have to be graduated by experiment. One method alone of the mechanical type is worth the attention of engineers.

The use of a rapidly rotating disc provided with apertures has been invented independently by many different workers as a means for reducing or adjusting the light. H. F. Talbot was probably the earliest. In the course of an interesting paper* on various optical experiments, he describes a rotating wheel. "If the wheel has eighteen spokes, each of which is a sector of 10°, their sum is 180°, and therefore a lamp seen through them loses one-half of its light....But since it is requisite to have the power of producing a *variable* obscuration, this may be accomplished by having a second wheel similar to the first, and placed close to it upon the same axis, so that they may be capable of being fastened together in any required position....positions may be found which will give any precise degree of obscuration that may be desired."

Simple as this method is, it does not follow that the eye will respond to a rapid succession of stimuli and will accept the sum of them in the proportion of the total angular aperture. Talbot's law, as it has been called, has been disputed, and certain experiments† have been adduced to show that the proportion is not constant. But the old masters of photometry were not prone to the mistakes of the hurried workers of to-day. They had time to verify before rushing into print with a paper or a patent. The eye is alone the judge, as Lambert wrote, and the eye is a curious instrument. Nothing but a searching experimental test could prove whether Talbot's assumption was correct. It was unlikely that any serious error could exist, for adjustable rotating sectors were

* *Phil. Mag.*, vol. v. (Brewster Series), 1834, p. 331.

† Ferry, *Physical Review*, vol. i., 1893 p. 338, and Stine, Photometrical Measurements, p. 25.

used in the long researches of Sir W. Abney and Gen. Festing, although much of their quantitative work was not pressed beyond 2 per cent. The matter has been examined by several workers, and has now been set at rest by the research of Mr. E. P. Hyde,* a research which has probably been unsurpassed in the whole history of photometry for careful attention to experimental detail and theoretical discussion. The probable errors of measurement were all under 0·1 per cent, the average deviation of the observations for any one angular opening was in no case as large as 0·2 per cent, and the observed apparent error in the law of proportionality was about 0·4 per cent, and this was possibly due to stray light under difficult conditions.

The use of rotating sectors may be divided into two kinds. The first is the reduction of a beam of light in a definite proportion in order to bring it within the range of other methods of photometric measurement. This is particularly useful in the case of powerful lights such as electric arcs. It was by the use of this method that I accidentally discovered the rotating phenomenon of the continuous current arc.*

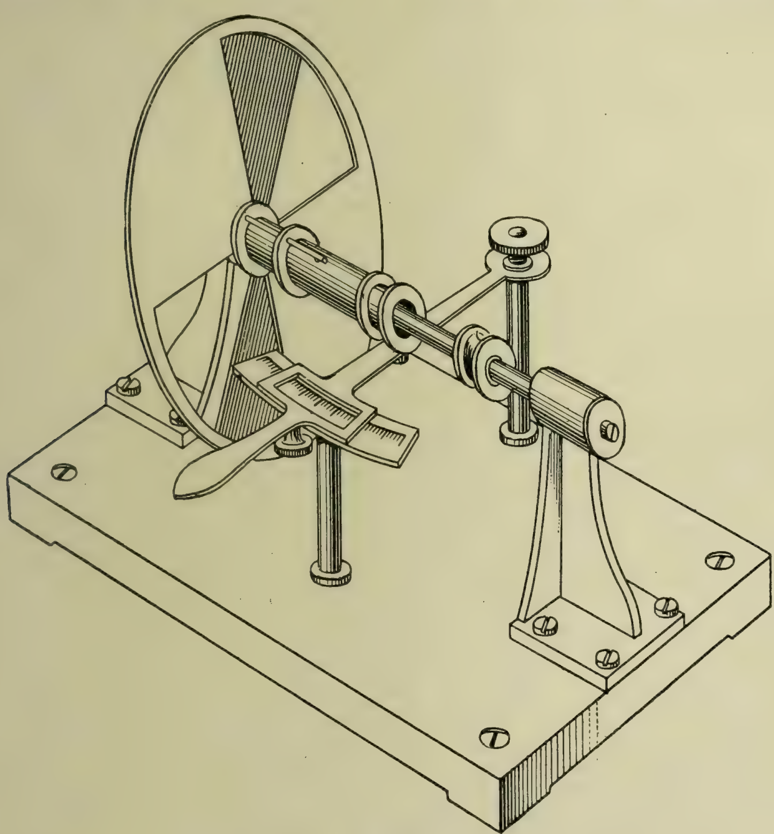


FIG. 89.—The Abney Sectors.

The second method is the adjustable control of a beam of light. In Talbot's original plan the disks had to be stopped, unclamped, readjusted, and restarted for every change of aperture. Sir W. Abney introduced, and others have independently devised mechanical arrangements for altering the aperture

* Hyde, 'Talbot's Law as Applied to the Rotating Sectored Disk,' *Bulletin of the Bureau of Standards*, Washington, vol. ii., No. 1, 1906.

* Trotter, *Proc. Roy. Soc.*, vol. lvi., 1894, and Cantor Lectures Soc. of Arts, 1895, vol xliii pp. 973-5,

while the disks are in motion, and his apparatus (Fig. 89) was so excellently made, that while there was no appreciable back-lash or lost motion of the adjusting lever, the movement was, to use the words of Count Rumford, "perfectly soft and gentle," and in this easy adjustment lies the secret of accurate photometry and the possibility of good photometry of lights of different colours.

A shaft carries near one end a grooved pulley by which an electric motor drives it, and at the other end a disk having two openings of 90°. A similar disk is mounted close to this, but free to turn on the shaft. Two pins project from this disk and enter holes in a flange. This flange forms part of sleeve capable of sliding on the shaft. A quick pitch screw groove is cut in the shaft, and a pin in the sleeve engages in this groove. The sleeve is provided with a grooved wheel, and a pin attached to a lever engages in the groove. By means of this mechanism the relative position of the two disks may be adjusted while they are in rapid rotation. The lever carries an index which moves over a graduated scale.

(*To be continued.*)

Light in Worship.

BY DR. M. GASTER.

(*Continued from p.* 522.)

THE reverence for the sacred fire took many shapes. Upon the maintenance of the permanent flame it depended whether the worship retained its efficacy and sacred character, for if it was extinguished danger threatened the community as well as the individual. Severe penalties, often death penalties, overtook the negligent priest or guardian. And yet whatever is entrusted to human care cannot be indefinitely guarded against mishap. An unexpected gust of wind, a shower over the unprotected part of the temple where the light was burning, any other untoward incident, or simple negligence to feed the sacred flame, might bring about the dreaded catastrophe. And then they could not expect another miracle to happen. Fire would not always fall from heaven, nor would the sacred fire, as on former rare occasions, suddenly leap up upon the altar as a symbol and proof of the god's acquiescence in the wish of the votaries. Artificial means had to be found to rekindle the extinguished light, and herein the evolution of the light in the worship enters upon a new and decisive phase: complete human mastery over the source of light. It was no longer heaven-sent, but it became henceforth the product of human skill. The secret which the gods had guarded so jealously had passed into the hand of man, who thus stood on a footing of equality with the divine in the production of the most subtle and most spiritual representative of life, of power, nay of eternity.

The same sacred character was therefore bestowed upon the winning of fire, and it played an important rôle in the religious life of many nations. The remembrance of the moment when they had succeeded in getting light became one of the principal festivals. In the course of time the festival changed its meaning, and the ceremonies enacted were interpreted differently—they had to be adapted to the changed views; but to those who follow these ceremonies up to their origin and throw light upon the darkened forms, they stand revealed in their primitive meaning. The birth of the earthly fire became the centre of an annual celebration, in which either the original manner in which fire had been produced was actually repeated or there was substituted for it some

other similar symbolical action. Thus in India on a certain day of the year a hundred of the head Brahmins would gather together, and in a tent specially prepared for the occasion, and surrounded by a large number of smaller tents filled by hundreds of priests, they would collect nine different kinds of wood, and then, placing a wooden pole in the middle of the altar, they would rub two pieces of wood together, the one soft the other hard, until through the friction a spark would be generated. The other logs of wood are then ignited, and thus the holy fire is again generated. Such, according to Jewish legend, was also the origin of the first fire. To the Parsis this was the most sacred form of producing the holy fire.

The date when this new fire was got was then celebrated as the day of new birth and of new life. To make it still more impressive in ancient Greece, in the island of Lemnos they used to extinguish the fire in all the dwellings for at least seven days. During these days sacrifices were offered and other lustration ceremonies carried out, until the ship which had gone to Delos to fetch the sacred fire hove in sight, and from it fire was given to every household, and a new life began.

The cult of St. Bridget in Kildare was also connected with a special renewal of the sacred fire kept within a hedge from which men were excluded. That fire could not be fanned by the breath of mouth, for fear of pollution, but only by means of bellows.

Similarly in Rome, when through a mishap the fire in the Temple of Vesta had been extinguished, they rekindled the flame by the same process as in India through rubbing a piece of wood on a wooden plank until a spark was generated, caught up by the vestal virgin, and carried into the temple for kindling the light there. This fire produced by friction was considered to be holy, and was used in many countries for religious and other purposes. The original meaning had been forgotten, but the remembrance remained that fire thus begotten was of a sacred character, and had quite a distinct virtue of its own, differing from the fire obtained by any other means. Not only was such fire sacred, and used exclusively for worship, but the day also on which the renewal of the divine light or of its recovery had taken place became an annual institution, accompanied by solemn celebrations and great display of light. Indispensable henceforth in the worship, the recovery and retention of it was of sufficient importance to cause annual rejoicings. And thus we get to the stage of illuminations on certain great occasions. This is a further development of the use of light which we are following up in these sketches. In Alexandria as well as in Jerusalem they had in ancient times special festivals of light. On a certain night —or nights—numerous lamps were lit, first in the Temple, then in private houses. In one case it was to remember the recovery of the light in the Temple in Jerusalem after it had been extinguished by the Greeks; in the other, to rejoice at the renewal of the light itself at the end of the cycle of a year. It was a purely religious festival, and the symbol of a religious idea. It was also an imitation of the divine light, a sign of homage to the creator or creators of light.

This custom spread. The temples were "illuminated" in honour also of other gods, the patron god to whom the same homage was paid as originally solely to the god of light, for he was for the time being the centre of the worship. The same ceremony was observed in his case as in that of the god of light, though he may not have had anything to do with light at all. It was merely a mark of divine honour. Herein we recognize the beginnings of the long process of "illuminations." It starts with the lighting-up on the day of the recovery of light in a given spot and on one occasion, and is then extended to many localities and to many gods. And when the Roman emperors claimed divine worship and were officially treated as gods, their name-day or birthday was then celebrated in a similar fashion by "illuminating" the temples and other public buildings and by processions

with torchlights or lamps. The purely religious form of worship was now degraded to that of homage to a human god. Here, then, is the origin of the modern torchlight processions in which people indulge, and also of the illuminations which are arranged to mark special name-days or historical events. Divine honour is thereby rendered to the objects of that illumination or procession, though no one is any longer conscious of its religious significance and remarkable origin.

Divine honour paid by the light of a lamp or a candle kept permanently burning has still survived in the lamp kept burning in front of special saints, either the patron of the place or of the house. To this very day one can see the lamp burning in front of the Russian Ikons or other saints in different parts of Europe. The anniversary is the signal for bonfires, modern and more humble, because popular representatives of the illuminations of old. In Europe it is principally at the festival of St. John, when the new light is kindled, that the remembrance of the old festival of producing fire is perpetuated. Fiery wheels are rolled down the hills, or other ceremonies are performed in some parts of Germany which remind us forcibly of the Indian feast of generating light. In exactly the same manner, nine different kinds of wood are selected, a pole is ignited by pulling a rope through a hole in it, and the fire thus kindled is used to light some straw wisps and bundles, and the cattle are also driven through the flame so as to ensure fertility and prosperity. In other places youths and maidens leap over the fire.

Such ceremonies are met with in many countries at Midsummer. Bonfires are lit and other symbolical ceremonies are added to it, due no doubt to altered circumstances. Other notions have now superseded the old-world views entertained by the peoples before they changed from Pagans into Christians. The old practices have remained, new have been added, and the whole has been adapted to the new order of things, and with them this use of the light in the worship and its transference from the temple to the house and from the one supreme deity to a multitude of gods and saints. And now one can understand the Christmas tree, with its lights kindled on the night of December 25th. It is not to be taken as a symbol representing the change from the winter to the summer, but as a ceremony absolutely identical with the ancient "illumination" carried out at every great and important occasion, the homage of light to the source of light, the divine light used to mark the divine. Of all the seasons of the year, none, however, has retained so clearly the fire in worship as the most prominent element as the Easter feast. Without going back to the ancient Easter or Ostara, the Teuton goddess of the springtide worshipped by kindling of new fire as in the island of Lemnos at the same period of the year, it suffices for our purpose to mention the celebration of Easter in the Church of the Holy Sepulchre in Jerusalem, notably by those who belong to the Greek Orthodox Church. The climax of the service is, as is well known, the descent of the Holy Fire; the candelabrum in the centre of the church is suddenly seen ablaze, and the worshippers—of whom each one is carrying a taper—fight madly to reach the flame and to kindle the light, and then rush through the streets of Jerusalem with the lighted tapers in their hands. The fire, though started by the monks, is none the less looked upon as of divine origin—it comes from above, and is the visible symbol of the Resurrection.

To the throng assembled there spiritual illumination must still be supplemented by physical light, for it is to them as sacred as the light lit in olden times by the pious worshipper in front of and in honour of his god. Thus the old lives in the new, and we carry the past with us into the future.

Tests of Headlights for Motor Cars and Motor Cycles, 1909.

(*Under the Open Competition Rules of the Royal Automobile Club.*)

For permission to publish this official account of the tests we are indebted to the Royal Automobile Club, under whose supervision they were undertaken at the Crystal Palace on July 19th of this year. We are also indebted to the courtesy of the journal of the Club for the use of the blocks following this report.

THE JUDGES.

Mr. Mervyn O'Gorman (*Chairman*). Captain R. K. Bagnall-Wild, R.E., Mr. G. H. Baillie, Rev. P. W. Bischoff (A.-C.U.), Professor C. Vernon Boys, F.R.S., Mr. A. G. New, Dr. W. Watson, F.R.S.

The Committee of the Club, having been requested by the Local Government Board to investigate and report upon headlights used upon motor vehicles, instructed the Expert and Technical Committee, by a minute dated November 4th, 1908, to carry out the necessary tests and to prepare a report.

Prior to the decision to carry out these tests the Club had been inquiring into the causes which contribute to the unpopularity of motor cars with a certain section of the public, and, amongst other matters, had given attention to the objection raised against the use of dazzling headlights carried on some motor cars and motor cycles. It is recognized that the way that many of these headlights are used is a source of annoyance to other users of the highway on account of their dazzling effect.

The Club was of opinion that this effect could be minimized, and at the same time sufficient illumination of the road in front of the driver of a motor car or a motor cycle be provided, if the beam of the lamp were arranged or controlled to better advantage.

The Club was aware that many lamp manufacturers had already directed their attention to this matter, and that some of them had produced lamps with this object in view. While it was considered that the universal employment of back and front lamps on all vehicles, horse-drawn or otherwise, would be an effective way of reducing the demand for headlights of high power, it was hoped that the tests would bring out the necessary points to be considered in the building of a successful lamp. This hope has been justified.

REPORT OF THE JUDGES.

To the Committee of the Royal Automobile Club.

1. The judges are pleased to report that the principal lamp makers responded to the invitation of the Club to submit their productions for the tests, which were of a searching nature, and were so arranged as to demonstrate the optical properties of the lamps. Thanks to this co-operation, a thorough investigation was possible, and the tests proved that the dazzling effect of headlights could be minimized, while at the same time sufficient light could be provided.

2. The entry list was fully up to expectations, the firms engaged numbered 21, and the number of entries was 47. See Table I. Of these 33 were acetylene, 12 electric, 1 petroleum, and 1 petrol-oxygen.

3. The entrant was invited to set his lamp to the best advantage in every respect, both the height and the angle of elevation being left to his discretion, and note was made of the height of each lamp above the ground (Table III., column *f*).* On the plans illustrating data obtained (Appendix II.) the height of the lamp above the ground is shown to scale by a point.

4. The records referred to in the following paragraphs were taken in respect of each lamp, and Table III. shows in summarized form the certificates of performance issued in each case to the entrant. The diagrams (Appendix II.) and the sketches and

* See end of Report.

illustrations (Appendix I.) also appear upon the certificates.

5. THE RANGE (*Table III., column g*).—The distance at which the lamp gave a certain standard of illumination (one-tenth of a candle-foot) was measured down a line along which the entrant had centred the beam of the lamp.

6. THE HORIZONTAL DISPERSION OF BEAM (*Table III., columns* h_1 *and* h_2).—The width of the beam over which the illumination of the head lamp was not less than the standard was measured at half the above range, firstly, at 3 ft. above the ground, and secondly, at the eye level, assumed for the purpose of this test to be 4 ft. 6 in. from the ground. The width of the beam at 3 ft. above the ground was taken, because a maximum of illumination obtained at this level is useful to the driver and does not cause trouble from glare.

7. The standard of light upon which the photometric measurements were based was the same for all the lamps, viz., one-tenth of a candle-foot; that is, the illumination received upon a surface 1 ft. from a source of light measuring one-tenth of a candle-power.

8. The judges adopted this standard as giving a range at which details could be distinguished, but it should be remembered that the useful range of the lamps, *i.e.*, that at which objects can be seen, is often substantially greater than that given in column *g* of Table III. The full effective range depends upon the nature of the object, *e.g.*, its size and colour contrast.

9. THE DAZZLING EFFECT (*Table III., column k*).—The distance in front of the lamp at which an observer could distinguish an object placed 6 ft. to the side of, and 6 ft. beyond, the lamp, was measured. The object chosen was such that it could be discerned on a starlit, moonless, clear night at a distance of 100 ft. in the absence of any headlight.

10. BACK REFLECTION (*Table III., column m*).—The term back reflection is used to denote the stray light thrown out rearwardly. Such stray light interferes seriously with the vision of the driver, and thereby operates to diminish the effectiveness of the lamp.

11. Prior to the tests the naked candle-power of the burners and bulbs was officially measured. These results and the corresponding consumption

TABLE I.—*List of Entrants.*

Name.	Address.	Number of lamps.	Acetylene.	Electric.
Badger Brass Manufacturing Co. ...	32, Featherstone Street, E.C. ...	6	6	—
Blériot, Ltd.	53–54, Long Acre, W.C.	3	1*	1
Brown Bros., Ltd.	23–34, Great Eastern Street, E.C....	2	2	—
Alfred Dunhill, Ltd.	359–361, Euston Road, W.C. ...	1	1	—
C. H. Gentry	173, Piccadilly, W.	1	—	1
S. Hall & Sons, Ltd.	18–20, Swinton Row, Edinburgh ...	1	1	—
Howes & Burley, Ltd...	Bishop Street, Birmingham ...	1	1	—
Motor Accessories Co.	55, Great Marlborough Street, W....	1	1	—
Reflector Syndicate, Ltd.	82, Victoria Street, S.W.	1	1	—
Rotax Motor Accessories Co... ...	43–45, Great Eastern Street, E.C....	3	2	1
Rushmore Lamps, Ltd.	49, Rupert Street, W.	3	3	—
Salsbury Lamps, Ltd....	124, Long Acre, W.C.	2	2	—
S. Smith & Son, Ltd.	9, Strand, W.C.	2	2	—
Sylverlyte Electric Lamp Co., Ltd...	11, Poland Street, W.	4	4	—
W. Tweed & Co.	43, Tabernacle Street, E.C. ...	1	1	—
Universal Motor Imports, Ltd. ...	10, Wilmington Street, E.C. ...	1	1	—
C. A. Vandervell & Co.	Warple Way, Acton Vale, W. ...	5	—	5
Weill Bros.	59-61, Hatton Garden, E.C. ...	5	5	—
Willocq-Bottin Motor Lamp Co. ...	139, Long Acre, W.C.	1	1	—
Worsnop & Co., Ltd.	Halifax	1	1	—
Wyncott & Son	281, Gt. Colmore St., Birmingham ..	2	1†	—

* Also one petrol-oxygen. † Also one paraffin.

figures are shown in columns *a* and *b* of Table III.

12. For the sake of facilitating reference the acetylene and electric lamps have been arranged according to their candle-power, and the details of one lamp, the petrol-oxygen, which is a type of limelight, have been set out separately.

13. DESIGN AND GENERAL CONSTRUCTION (*Table III., column l*).—The lamps remained in the possession of the Club after the Tests, in order that the design and general construction might be investigated; at the same time sketches were made of the optical arrangements of the lamps, and are shown in Appendix I.

14. Under the heading of simplicity of design and general construction, the Judges attach importance to the following points:—Weight for size; ease of cleaning; absence of liability to rattle; fewness of parts; quality of hinges, clasps, supporting sockets, &c.; and general method of assembling the lamp. Many of the lamps examined showed that entrants had paid considerable attention to these points.

15. The measurement of the candle-powers of the sources of light has brought out the fact that the generally accepted idea of the intense candle-power of headlights is erroneous. The naked light of a head lamp such as is usually employed is from 15 to 25 candle-power, and this light is collected and directed by lenses and mirrors. Thus Table III., column *a*, shows only two acetylene burners exceeded 30 candle-power, while in the case of electric lamps the number was the same.

16. In the opinion of the judges, so long as the optical arrangements of the lamps are efficient, ample illumination is afforded by about 20 candle-power, which can be obtained in the case of an acetylene lamp with a consumption of about ·7 cubic feet of gas per hour (about 2·8 oz. of calcium carbide), and in the case of an electric lamp with a consumption of about 21 watts.

17. It is to be noted that the larger the mirror and the smaller the source of light, the easier it is to avoid undesired dispersion of the beam. Accordingly, when considering the advantage of a light-weight lamp, the importance of the size of the mirror must not be overlooked. The weight of all lamps is given in Table III., column *e*. The lamps marked †† are self-contained, and were weighed with the generator empty.

18. For the purpose of the tests the relation of both pressure and consumption of gas to candle-power was investigated. Some examples of these tests are shown in Table II.

TABLE II.—*Table Showing Relation of Candle-power to Pressure and Consumption of Gas.*

Burner.	Nominal consumption, cu. ft. per hour.	Pressure, inches of water.	Candle-power.	Consumption, cu. ft. per hour.	Candle-power hours per cu. ft.
i.	·35	6	13	·70	18·5
		4	11	·55	20
		3	10	·45	22·2
		2	7	·33	21·2
ii.	·5	7·8	8	·70	11·4
		6	11	·65	16·9
		4	8	·48	16·6
		3	8	·41	19·5
iii.	·5	6	13	·78	16·6
		4	11	·57	19·3
		3	11	·48	22·9
v.	·62	6	17	·87	19·5
		4	16	·67	23·9
		3	17	·60	28·3
		2	13·5	·47	28·8
		1	6	·29	20·7
v.	·62	6	20	·88	22·7
		4	18	·68	26·4
		3	17	·60	28·3
vi.	·88	6	52	1·48	35·1
		4	44	1·24	35·5
		3	36	·95	37 9

19. From these experiments it will be observed that the candle-power of an acetylene burner varies but little between pressures of 3 in. and 6 in. of water, but the consumption rises to an important degree. In the opinion of the judges, lamps and burners as now constructed require no pressure higher than 4 in., and the most economical pressure is 3 in. of water. Increasing the size of the burner has small effect upon the range, unless the optical system is altered proportionately. Increasing the size of the burner tends to increase the width of beam, and in some cases the glare.

20. The effect of variations of voltage on electric lamps depends upon the substance of which the filament is made. The increase of light resulting from an increase of voltage in the case

TABLE III.—SUMMARY OF RESULTS OBTAINED.

		a	b		c	d	e	f	g	h1	h2	k	l	m
No.	Name of Entrant.	Candle-power of naked light.	Consumption. Cu. ft. pr. hr.	Consumption. Watts	Pressure.*	Diameter of front aperture of lamp.	Weight.	Height of lamp from ground.	Range.	Width of beam at half range. At 3ft. from ground.	Width of beam at half range. At 4ft. 6in. from ground.	Distance from lamp at which dazzle ceased, at 4ft. 6in. from ground.	Remarks on design and construction.	Remarks on back reflection (stray light thrown out rearwardly).
					volts.	in.	lb. oz.	ft. in.	ft.	ft. in.	ft. in.	ft.		
1	Vandervell & Co.	3·9	—	·4	8·2	4¾	2 1	3 0½	43½	8 6	8 6	22	Good	No stray light
2	Badger Brass Mfg. Co. ..	4·2	·43	—	—	4 1-16	2 7	2 7	51	8 7	7 2	26	Very good	Light issued round rim of front; also reflections from the body of the lamp
3	Wyncott & Son	4·8	Paraffin			6⅛	††5 8	3 8½	30	7 0	6 10	15	Fair	No stray light
4	Vandervell & Co.	5·0	—	3·9	4·2	4¾	1 12	3 1	78	7 0	7 3	29	Fair	No stray light
§5	A. Dunhill, Ltd.	7·9	·45	—	—	6½	††13 15	2 10	69	7 3	5 11	35	Good	No stray light
,,	Do. (without screen)	,,	,,	—	—	,,	,,	,,	93	9 5	9 9	30	,,	,,
‡6	S. Smith & Son, Ltd.	11·3	·46	—	—	7½	††13 19	2 10	81	5 8	5 0	37	Good	Light was visible through a row of holes partially hidden by the top of the generator
7	Rushmore Lamps, Ltd. ..	12·5	·63	—	—	6⅞	7 15	2 3½	87	11 8	10 8	31	Very good	No stray light
‡8	S. Smith & Son, Ltd.	13·5	·64	—	—	6½	††12 13	2 10	64½	8 5	7 8	41	Good	Light was visible through a row of holes partially hidden by the top of the generator
9	Rotax Motor Accessories Co.	13·8	·69	—	—	6⅝	††11 0	2 6½	67½	10 11	13 1	21	Good	Light issued from two ventilating holes in the cowl and from the rim of front of lamp
10	C. H. Gentry	16·2	—	16·8	8·4	7	4 5	2 5½	189	5 5	4 8	12	Very good	No stray light
,,	Do. (½ voltage)	7·5	—	8·3	4·2	,,	,,	,,	22½	4 5	3 6	21	,,	,,
11	Weill Bros.	16·3	·66	—	—	6⅞	††9 8	2 8	78	10 3	8 9	22	Fair	A very slight amount of light was visible from a row of small holes
12	Weill Bros.	17·8	·68	—	—	5⅜	3 5	2 7½	43½	13 5	13 3	21	Fair	A small amount of light issued from the ventilating holes
13	Vandervell & Co.	18·9	—	13·7	12·4	6⅝	4 2	3 0½	126	26 4	25 6	7	Good	No stray light
14	Rushmore Lamps, Ltd. ..	19·1	·72	—	—	6⅛	8 2	2 4	94½	14 7	13 0	27	Very good	A very slight amount of light was visible from the rim of front of lamp
15	Rotax Motor Accessories Co.	19·2	—	21·4	12·1	6⅝	5 13	2 7	81	15 3	15 3	5	Very good	No stray light
,,	Do. (2nd filament)	5·9	—	—	4·0	,,	,,	,,	57	3 4	3 0	30	,,	,,
**16	Salsbury Lamps, Ltd... ..	20·2	·76	—	—	7½	11 4	2 3½	84	13 9	11 6	35	Very good	Practically no stray light
17	Sylverlyte, Ltd.	20·8	—	21·0	14·1	4¾	7 10	3 1	85½	14 10	15 0	16	Fair	No stray light
18	Salsbury Lamps, Ltd... ..	20·8	·72	—	—	7⅞	8 13	2 4½	93	18 0	17 0	27	Very good	A small amount of light was visible through a row of small holes

§ No. 5.—Fitted with flat, blackened, circular slats behind front glass.
‡ Nos. 6, 8, and 19.—Fitted with gold-plated reflector.
** No. 16.—Fitted with front lens cut horizontally into a large number of sections, the adjoining faces of which are frosted.
¶ No. 20.—Fitted with flat, blackened, horizontal slats behind front glass, movable by hand.
†† These lamps are self-contained; the weight therefore includes that of the generator.

TABLE III.—SUMMARY OF RESULTS OBTAINED (*continued*).

		a	b		c	d	e	f	g	h_1	h_2	k	l	m
No.	Name of Entrant.	Candle-power of naked light.	Consumption. Cu. ft. pr. hr.	Consumption. Watts	Pressure.*	Diameter of front aperture of lamp.	Weight.	Height of lamp from ground.	Range.	Width of beam at half range. At 3ft. from ground.	Width of beam at half range. At 4ft. 6in. from ground.	Distance from lamp at which dazzle ceased, at 4ft. 6in. from ground.	Remarks on design and construction.	Remarks on back reflection (stray light thrown out rearwardly).
					volts.	in.	lb. oz.	ft. in.	ft.	ft. in.	ft. in.	ft.		
‡19	Reflector Synd., Ltd. ...	22·5	·79	—	—	7⅞	12 4	2 8½	97½	12 7	11 4	36	Fair	Slight amount of light issued from holes on the top
¶20	Rushmore Lamps, Ltd. ...	22·7	·83	—	—	7¼	11 3	2 4	75	8 7	5 5	29	Good	No stray light
,,	Do. (half eclipsed) ...	,,	,,	—	—	,,	,,	,,	27	2 11	0 0	33	,,	,,
21	Badger Brass Mfg. Co. ...	23·6	·80	—	—	9	10 14	2 10½	126	13 9	13 1	30	Fa	Light issued from ventilating holes in the cowl and from a row of holes on the top
22	Wyncott & Son	24·5	·82	—	—	6½	††12 6	2 6	69	6 10	3 9	26	Fair	A small amount of light issued from the ventilating holes
23	Weill Bros.	25·0	·95	—	—	8⅛	8 3	2 6	97½	11 9	9 7	29	Good	Very slight amount of light issued from holes on the top
24	Weill Bros.	25·6	·85	—	—	8⅝	9 6	2 8	93	9 11	10 2	27	Good	A large amount of light issued through a long narrow aperture
‖25	Blériot, Ltd.	26·0	·81	—	—	9¾	16 0	1 10	132	21 6	19 2	27	Fair	A considerable amount of light issued from the top
26	Worsnop & Co., Ltd. ...	26·2	·91	—	—	8¾	12 2	2 6	54	18 11	15 6	12	Fair	A very slight amount of light was reflected from holes on the edge of front
27	Motor Accessories Co. ...	26·3	·81	—	—	7⅞	12 5	2 4	75	13 9	12 2	6	Good	A bright light issued from the ventilating holes
28	Howes & Burley, Ltd. ...	28·7	·95	—	—	7½	7 0	3 1	78	†21 3	4 1	7	Good	No stray light
29	Brown Bros., Ltd.	32·2	·95	—	—	9½	16 4	2 10	187½	22 9	22 3	7	Fair	Light issued from two ventilating holes in the cowl
,,	Do. (eclipsed)	,,	,,	—	—	,,	,,	,,	24	16 11	16 10	7	,,	,,
30	Vandervell & Co.	33·0	—	22·3	12·4	7¾	6 14	2 8	160½	20 3	20 10	9	Good	No stray light
31	W. Tweer & Co.	37·7	1·07	—	—	7¾	8 0	3 0	93	16 7	16 8	11	Good	Light issued from round cowl, and there were reflections towards the wings
‖32	Blériot, Ltd.	76·9	—	68·3	13·0	9¾	12 8	1 10	168	20 5	17 3	30	Fair	No stray light
,,	Do. (without louvre) ...	,,	—	,,	,,	,,	,,	,,	216	25 7	23 7	7	,,	,,
33	Blériot, Ltd.	181·0	—	—	—	10½	23 5	2·1	1032	31 10	30 10	10	Very good	Some light was thrown back from the cowl

* In the case of the acetylene burners, the candle-power (*a*) and consumption (*b*) correspond to a pressure of 3in. of water.
† This width was broken by two small patches where the intensity of the light did not quite reach the standard. (See Appendix II.
‖ Nos. 25 and 32.—Fitted with fixed, blackened, horizontal slats behind front glass.

of metallic and carbon filaments is shown in the following table. For example, a 5 per cent increase of voltage gives approximately a 31 per cent increase of light in the case of a carbon filament lamp, and 23 per cent in the case of one with metallic filament.

21. In certain cases the electric lamps were somewhat overrun, and if this practice became general it would lead to objectionable results, on account of the blackening of the bulbs and premature breakage of filaments. The candle-power of the electric lamps shown in Table III., column *a*, corresponds to the voltage at which the lamps were actually run during the tests.

TABLE IV.

Variation of Candle Power compared to Variation of Voltage.

Percentage of voltage to that of normal.	Percentage of candle-power to that of normal voltage.		
	Carbon.	Tantalum.	Tungsten.
85	41	50	55
90	56	64	67
95	75	80·5	82
100 (normal)	100	100	100
105	131	123	119
110	168	148	141

22. A series of experiments were carried out to ascertain the effect on dazzle of varying the vertical angle of projection of the beam and the height of the lamp itself from the ground.

23. The figures given in the following Table V. represent in general the results of the tests made. The figures in feet in the different columns are the distances of the observer from the lamp at which he was no longer dazzled—a similar set of observations to those shown in Table III., column *k*.

24. This table shows that the least dazzle is obtained either when the lamp is very low down (2 ft. from the ground), or when it is fixed above the canopy level (7 ft. 6 in. above the ground). When the lamp is at, or about, a height of 3 ft. from the ground, a downward tilt increases the dazzling effect. The judges are of opinion that this is due in a measure to reflection from the surface of the road, although this was not as light in colour as is often the case.

25. When the lamp was tested below the level of 3 ft. from the ground, maximum dazzle was obtained with an upward tilt.

Nevertheless, the effect on dazzle of tilting the lamp within reasonable limits is unimportant.

26. Undue tilt of the lamp causes considerable difference in the illuminating power, whereas height has an appreciable effect in diminishing the dazzle.

The best position would appear to be at 2 ft.

27. As regards illumination the horizontal is the best position from the driver's point of view, except at a height of 7 ft. 6 in., when a slight downward tilt is desirable.

TABLE V.

Effect of Height and Angle of Elevation upon Dazzle.

Angle of Elevation.	Height of Lamp from Ground.				
	2 ft.	3 ft.	4 ft.	5 ft.	7 ft. 6 in.
	ft.	ft.	ft.	ft.	ft.
20 deg. up	39	—	—	—	—
10 deg. ,, ...	55	43½	42	28	55
5 deg. ,, ...	57½	46	46	33	—
0 deg. (horizontal) ...	57	45	39	22	59
5 deg. down	64	35	34½	23	—
10 deg.	62	36	26½	24	51

28. The automatic anti-dazzling devices other than specially arranged mirrors or lenses appeared in every case to diminish the range, but in one case this effect was only slight.

29. Three lamps were provided with gold reflectors, a development which is expected in consequence of the colour to prove of advantage in time of fog. It was not possible to adjudicate, in this respect, upon these or other lamps with similar claims, owing to the absence of fog during the test.

30. Appliances can be added to almost any type of head lamp whereby the light may be reduced; for example, with electric lamps by a switch diminishing the voltage or inserting resistance, and with acetylene lamps by partly or wholly obscuring the light by means of hand-actuated shutters

or screens. The advantage of such a hand-actuated device is that on entering a town the intensity of the light upon the head lamp can at once be moderated.

31. The lamps have been tested singly, but in many, if not in most cases, users employ a pair of lamps. It should be noted that a wider beam is required from a lamp which is to be used singly.

32. In consequence of the time and labour which would have been involved had all the lamps which entrants wished to submit been tested, it was decided to accept from them only those lamps which were of distinct types, irrespective of candle-power. Accordingly, it must be remembered that in most cases the manufacturer of a high-power lamp also makes small and medium-powered lamps, and *vice versa*.

33. The judges desire to express their thanks to Mr. Carl Opperman for the loan of electric apparatus, to Messrs. The Acetylene Illuminating Company, Limited, for providing dissolved acetylene, to Messrs. Elliott Brothers, for the loan of scientific instruments, and also to those who rendered assistance. By order of the Judges,

J. W. ORDE, Secretary.

119, Piccadilly, London, W.,

Aug. 4th, 1909.

Illustrations of some Lamps reported upon (Appendix I.).

No. 5.—A. Dunhill, Ltd.

No. 7.—Rushmore Lamps, Ltd.

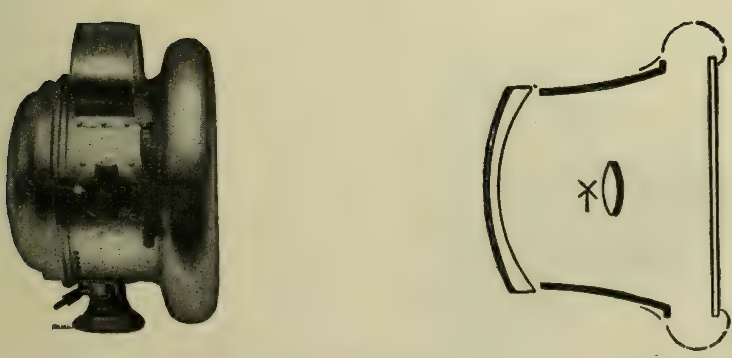
No. 10.—C. H. Gentry.

No. 14.—Rushmore Lamps, Ltd.

No. 15.—Rotax Motor Accessories Co.

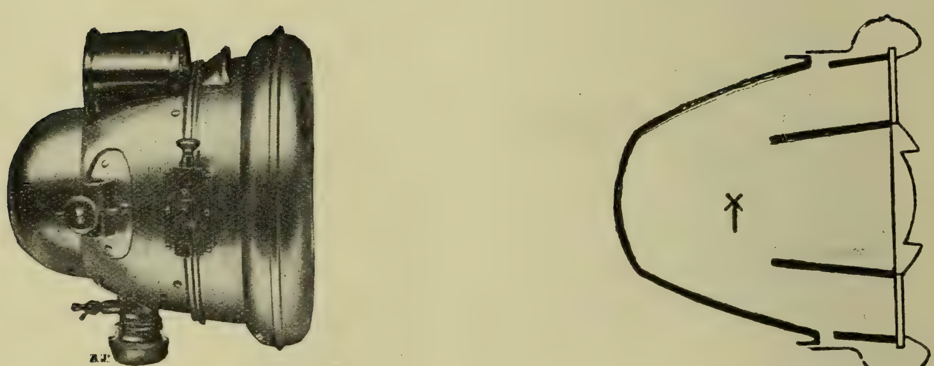
No. 16.—Salsbury Lamps, Ltd.

No 17.—Sylverlyte, Ltd.

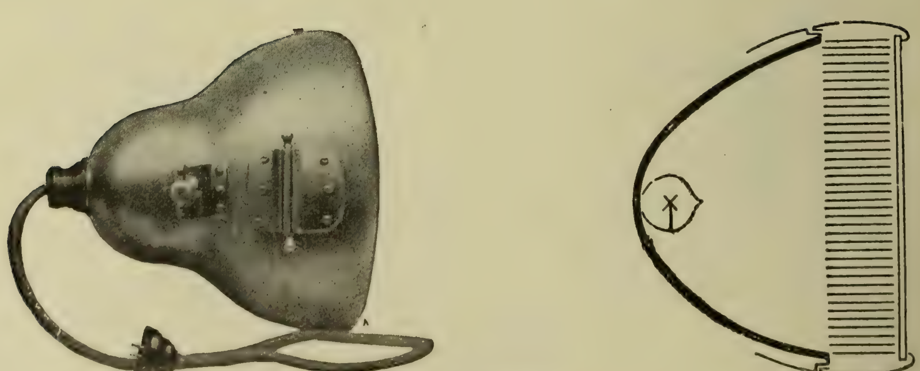


No 18.—Salsbury Lamps, Ltd.

No. 24.—Weill Bros

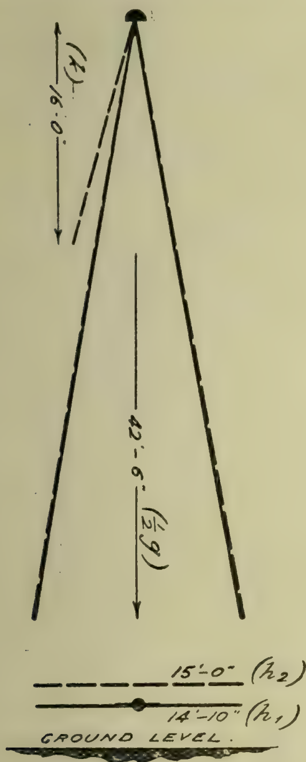


No. 26.—Worsnop & Co., Ltd.

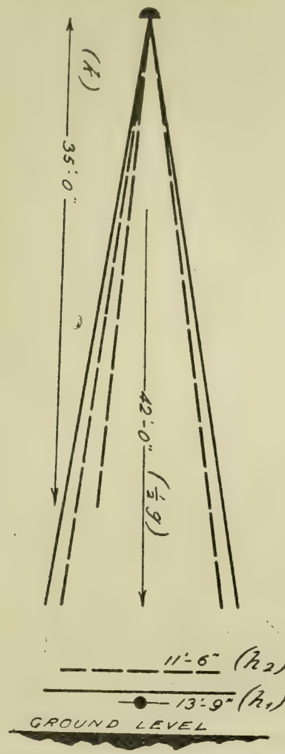


No. 32.—Blériot, Ltd.

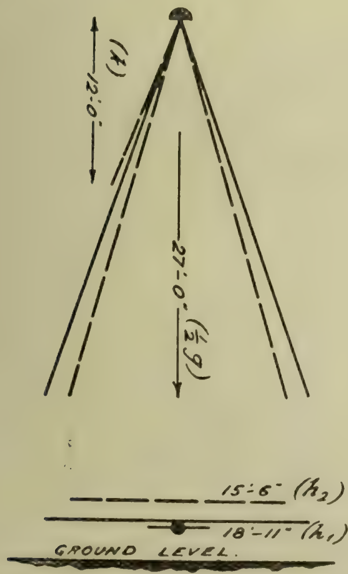
Some Illustrations of Data obtained in Tests of Motor Headlights (Appendix II).



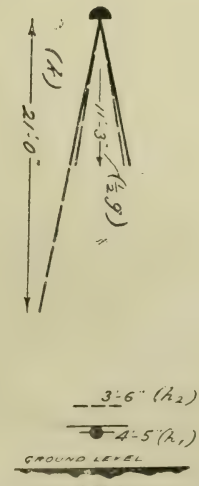
No. 17.—Sylverlyte, Ltd.



No. 16.—Salsbury Lamps, Ltd.



No. 26.—Worsnop & Co.



(Half Voltage.)
No. 10.—C. H. Gentry.

Methods of Illumination in the Middle Ages and previous to the Nineteenth Century.

(Das Beleuchtungswesen vom Mittelalter bis zur Mitte des xix. Jahrhunderts aus österreich-ungarn, insbesondere aus den Alpenlandern und den angrenzenden Gebieten der Nachbarstaaten, by Ladislaus Edler von Benesch. Verlag von Anton Schroll & Co., Hegelgasse 17, Vienna. Price 42 Marks.)

We have previously referred to the exceedingly complete collection of ancient forms of lamps and fixtures which the author describes in the above work (see this journal, July, 1909, p. 491; August, 1909, p. 525). This embraces 1260 different specimens of old types of lamps, &c., forming part of a valuable collection in the Kaiserhaus; they are illustrated by 60 excellent plates.

The author divides the illuminating apparatus discussed into twenty-one main groups, in which he traces the gradual evolution of simple yet often ornamental types of fixtures from a prehistoric stage up to the Middle Ages. The earliest genuine source of light seems generally recognized to have been the hearth-fire, reference to which occurs in the 'Odyssey' of Homer and other ancient literature. The use of splinters and inflammable wood goes back to a very early date; the author states that such means of illumination undoubtedly were known to prehistoric man, and are found among the remnants unearthed of his existence.

In our last number we reproduced an illustration showing this method in use at an old smithy at Mühlviertel in Upper Austria. A similar device, consisting merely of a splinter fixed in position on an adjustable arm is shown in Fig. 1. A yet more simple means of illumination consisted in the mere insertion of pieces of in-

Fig. 1—Holder for Kindled Pine-Splinter.

flammable wood in stone sockets resting on the floor, or in niches in the wall of the building; lighted splinters were also sometimes enclosed in boxes, one side of which was open and turned towards the occupants in the room.

Fig. 2.—Metal Carrier for Inflammable Wood Splinters, &c.

A simple device of this kind of later date, which yet shows some conception of the principle of draught and ventilation, is shown in Fig. 2. A much more elaborate design, from the artistic standpoint, is that in Fig. 3. It seems to have been generally recognized that this type of illumination did not suffice for the carrying on of much work; it merely served to produce a cheerful impression in the rooms in the evening. In those days "the night when no man can work" had a very real significance.

The development of fixtures to hold the illuminant soon led to more complex forms of light, but they served merely to hold liquids, fat, oil, &c. Simple in principle, they were also ineffective as illuminants, judging by modern standards, but often wonderfully successful as an embodiment of artistic design. It is striking to observe how, in times when the utilitarian possibilities of artificial light were so little realized, men were, nevertheless, willing to expend a degree of trouble on the design and ornamentation of fixtures, which is less frequently bestowed at the present time.

The introduction of candles was followed by the development of more or less elaborate candle holders about the fifteenth century; many of these were exquisitely proportioned, and formed the basis of models of the present day. It is stated, however, that the ornamentation of these holders was carried to such an extent at one stage in their evolution that the fixtures became somewhat unsteady and easily upset as a consequence. Some of the simplest types will be seen in Fig. 4. It will be observed that some of these fixtures are provided with screens by which the light is blocked in certain directions, and several are also provided with extinguishing and snuffing apparatus.

Special elaborate methods were formerly adopted for the extinguishing of candles, &c. Large conical extinguishers, which were merely dropped over the flame to be put out, were a recognized and simple device. In some cases an ingenious arrangement was fitted to the candlestick which provided for the extinguishing of the flame, as a measure of safety when the candle had burnt down to a certain limit. These extinguishers, however, were also often made the subject of very elaborate ornament, and many are the quaint designs shown by the author in this volume. It is interesting to observe, from the variety of types illustrated, how large a place the extinguishing of such lights occupied in the minds of designers. To-day our means of extinguishing gas and electricity are, comparatively, so simple and convenient that it is a little curious to observe the elaborate effort often expended on this little detail. Arrangements for trimming candle-wicks, &c.,

are the subject of similar careful study.

Candles and dishes of liquid fat, &c., were eventually followed by oil lamps. Some forms of old oil lamps are shown in Figs. 5–7. Here again the old forms of oil lamps seem to have been form of lamps were much admired. Many forms of lamps give evidence of having passed through a considerable stage of their evolution in the service of the Church. The hanging chains and so forth adorning modern fixtures can be traced to this influence.

FIG. 3.—Ornamental Hearth carrying Inflammable Wood-Splinters.

generally remarkable for beauty of design rather than efficiency as a lighting agent. The author mentions that many of the Roman and Carthaginian lamps excelled in this way, and that in more recent years the Venetian

The labour of filling up a large number of lamps of this kind would thus be regarded as a labour of love.

Special mention is made by the author of the beauty of design of the lamp shown in Fig. 5, which is of the

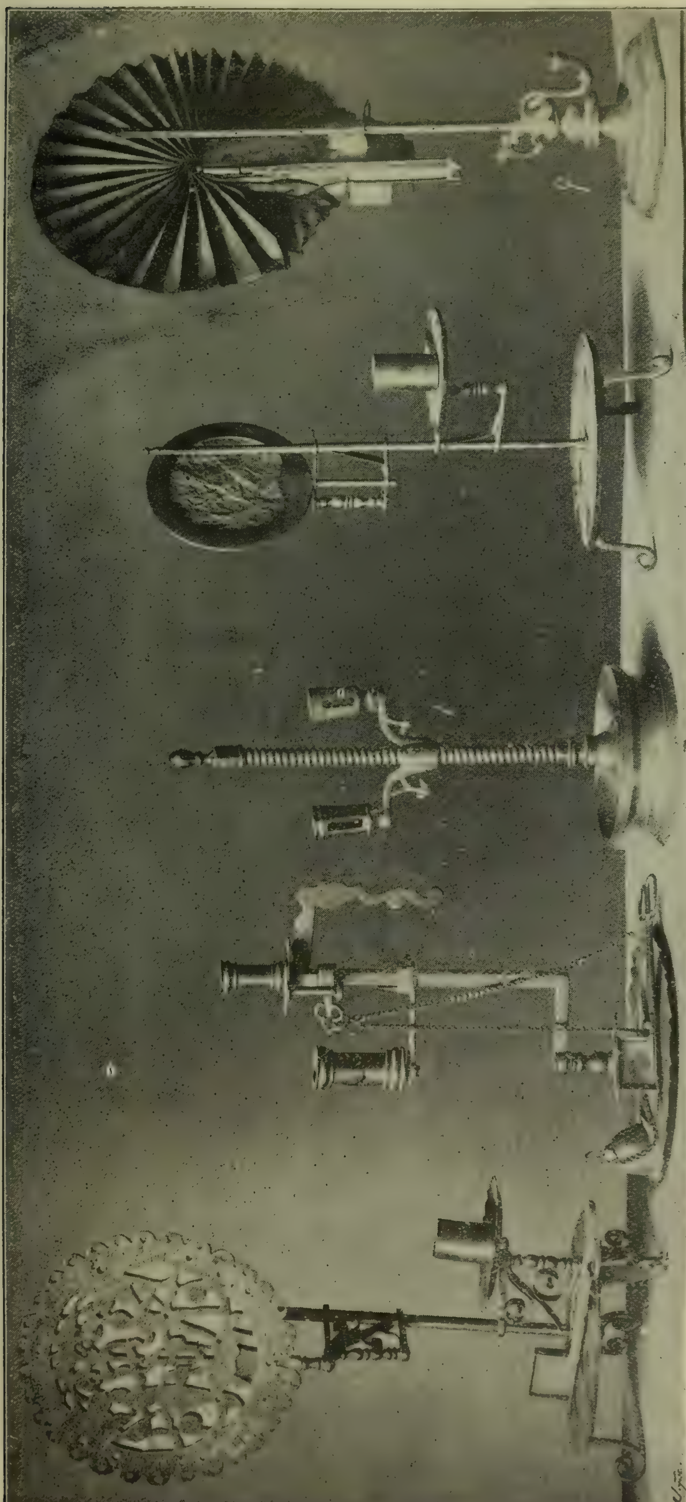


FIG. 4.—Antiquated Forms of Candle-Sticks provided with Screens, Snuffers, and Extinguishers.

early eighteenth century; part of the fixture, however, is missing. In Figs. 6 and 7 it is interesting to observe the scale in Roman numbers and indicating the hours; the level of oil thus served to indicate the time during which the lamp could be relied upon to burn without refilling. It will also be observed that the practical object of blocking the light in certain directions again receives attention, though it does not seem to have been often intended to make use of this for reflecting purposes; instead of this the aim was rather to use them as an additional opportunity for ornamentation. We find, however, that utilitarian considerations were not entirely lost sight of. For instance, some lamps were so arranged as to provide a night-light in the bedroom, and also to heat up a small vessel in which food or medicine, &c., could be placed.

Space does not allow us to refer to the many elegant forms of hanging and wall fittings described by the author, but these constitute a series which we hope to draw on for future illustrations for æsthetic principles. Some of these are shown in Fig. 8.

The provision of a lantern in order to screen the flame from draughts, &c., and to serve as a security against fire, was yet another stage in the development of these lamps. Some of these old lanterns are also wonderfully successful from the artistic point of view, and are often copied in the designs of the present day.

A special section of the book deals with kindling apparatus. This, like the extinguishing devices to which reference has previously been made, formed a very important subject for study in the earlier sources of light. The flint and tinder box was often an extremely ornamental object; but to obtain a light was often a somewhat tedious operation. In the seventeenth century burning glasses appear to have been developed to a certain stage of efficiency, but of course these were only of service on bright days when the rays of the sun were available.

A further stage in the development of kindling apparatus was of course the invention of matches. These at first consisted of splinters tipped with the mixture of sulphur and potassium chlorate, which were dipped into sulphuric acid. It was, therefore, necessary to carry about a bundle of these matches, and also a small box containing an asbestos-like fibre dipped in sulphuric acid. Inconvenient as this method doubtless was, it was a great improvement on the tinder box.

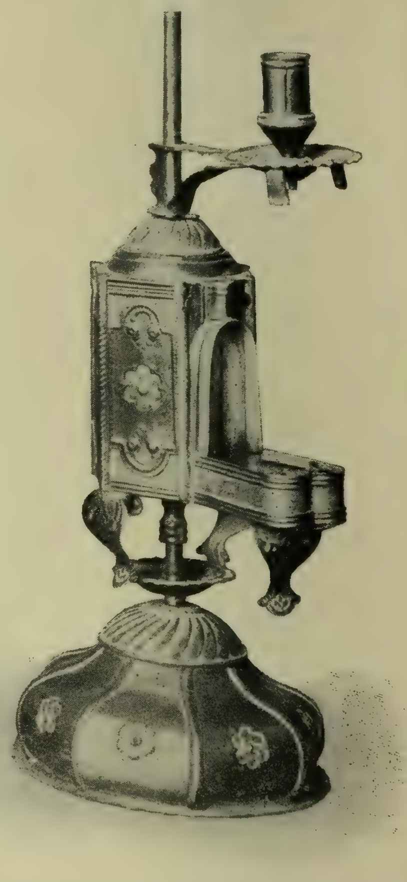


Fig. 5.—Old Form of Oil Lamp of Ornamental Design (early 18th Century).

The invention of rubbing matches is attributed to Irinyi in 1837. This

savant, we are informed, shut himself up in his room while studying the problem and refused to see any one for many days. In replying to all requests for admittance his only answer was "Go away, I am making a discovery." His rubbing matches, primitive in form as they were, formed the basis of our more convenient implements of the present day.

In this short note we have only been able to treat in a cursory manner a few features of this interesting work. It may be stated, however, that the extensive and elaborate collection of types of ancient fixtures will not only repay study by those interested in the historical aspects of illumination, but might doubtless be of considerable uggestive value to those concerned with the design of modern fixtures.

It may be questioned whether in the modern desire to improve the practical efficiency and serviceable nature of methods of illumination the æsthetic possibilities of fixtures are not sometimes sacrificed to a needless extent. It must never be forgotten that much illuminating apparatus, though actually not in use in the daytime, is nevertheless somewhat conspicuous. Street-lanterns, for example, are often decidedly prominent objects in the streets during the day, and lamps slung on wires spanning the streets are sometimes even more so.

During the night-time we do quite rightly in laying stress on the practical purpose of illuminants to provide

FIGS. 6 & 7.—Old Forms of Oil Lamps. Note the Hour-Gauge in Roman Numerals.

light, though even here the artistic side of the question cannot be ignored. But during the day the practical function of the illuminant is temporarily dispensed with, and we are chiefly concerned with its ornamental appearance.

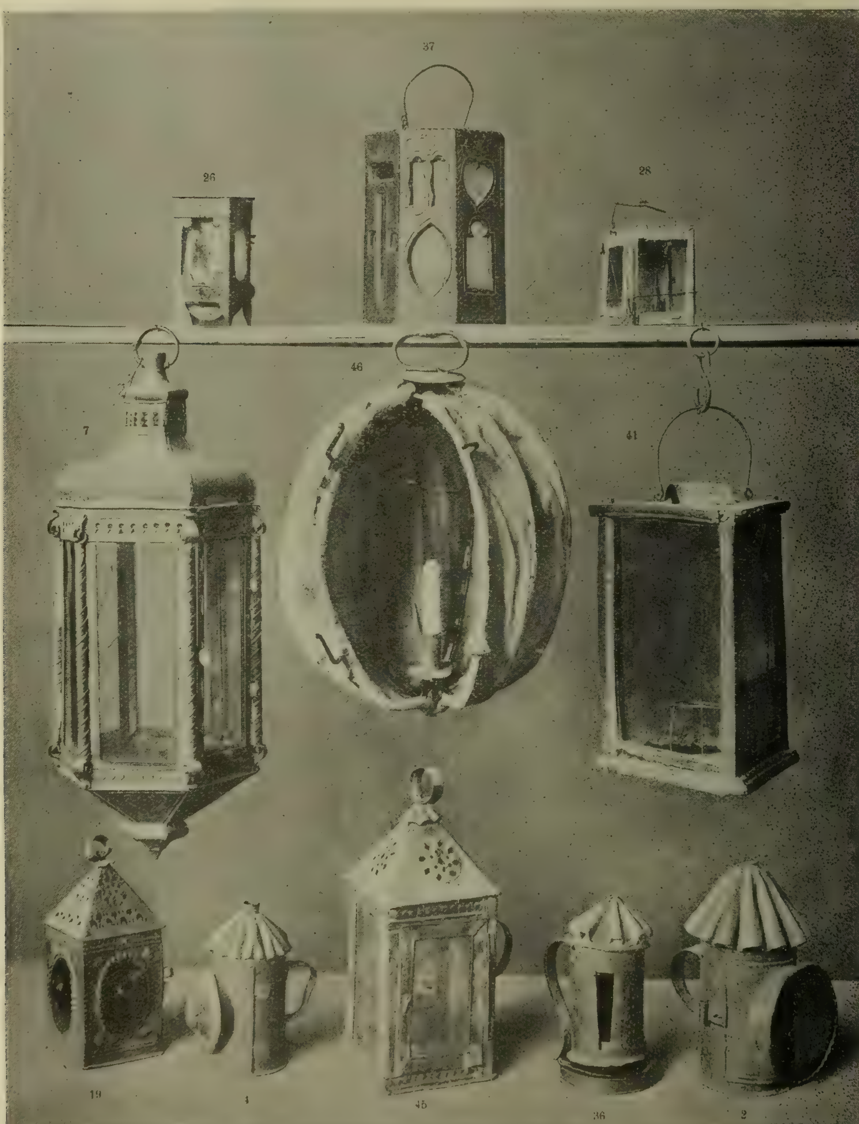


Fig. 9.—Ancient Forms of Lanterns.

There are, of course, also special instances in interior lighting, the case of church lighting for example, in which the artistic side is of even greater importance. In many churches we are met by a desire to make use of modern efficient illuminants, and yet to preserve the traditional appearance of the methods of illumination of the past. The engineer confronted with problems of this kind needs to understand the

FIG. 8.—Ancient Types of Wall-Fittings.

gradual evolution of the fixtures and lamps of to-day from those of the Middle Ages, and the study of ancient designs such as those described in this work should be of material assistance in providing him with inspiration for the future.

The Illumination of Statues.

CONSIDERABLE interest was aroused by the method of illuminating the Singer Building in New York by means of searchlights which was described in our first volume (*Illuminating Engineer*, vol. i. p. 739). Another instance of such methods of spectacular lighting which might also be of interest to our readers is furnished by the illumination of the gigantic statue of Bismark in Hamburg. This statue occupies a very prominent position and can be seen from almost any quarter of the town; it is also flanked by dark woods which help to render it a prominent white object.

Recently searchlights have been employed to illuminate the statue, with the result that its effective appearance by day is enhanced by night. When one considers that the statues erected to commemorate our great dead do not serve their purpose in the least during the night time, simply because they are invisible, the possibility of making them do double duty by suitable night illumination seems worth consideration.

Free Maintenance of Incandescent Burners for the Consumer.

IN a recent number of the *Journal of Gaslighting* we note a reference to the recent decision of the Croydon Gas Co., which is spoken of with approval. Recognizing that a satisfied consumer is the best advertisement, the Company are undertaking the free maintenance of all incandescent burners in the houses of consumers, a charge being only made for the actual cost of renewals. There is every reason to expect that adoption of this line of policy will be beneficial to Company and Consumer alike.

Illumination and Scenic Effects.

Some of the Side-Shows at Earl's Court Exhibition.

On Saturday, June 5th, an invitation was extended to members of the press by the authorities to visit the exhibition at Earl's Court, advantage of which was taken by the author, and a pleasant afternoon was spent visiting the various side-shows.

As might have been expected, a very close connexion could be traced between the exhibits and illuminating engineering; there were quite a number of illustrations of the use of light to produce scenic effects, which provided instructive object lessons to those interested in illumination. It is, indeed, striking to find how many such entertainments appeal primarily to the eye. In what follows some mention will be made of a few such illustrations which impressed the author, but no doubt many other instances at the Exhibition might be quoted.

One rather effective example of the ingenious use of light to produce illusions is afforded by the spectacle portraying, in a vivid manner, the coming of the deluge in the time of Noah. The gradual dawning of light and the rising of the sun discover the revellers, reclining after the previous night's entertainment, who deride Noah's warnings of the coming punishment. Then follows a vivid portrayal of gathering darkness, thunder and lightning, and eventually the continuous descent of a torrent of water from the heavens, until, in a subsequent scene, only the ark is seen tossing on the troubled waters. A feature of this spectacle is the ingenious use of a series of green incandescent lamps, flanked with reflectors and mounted so as to throw their light towards the audience. These lamps are extinguished or burn but dully when the stage is bathed in light, and it is desired to simulate eastern sunshine On the other hand, their gradually increasing brilliancy, coupled with the diminishing intensity of illumination of objects on the stage, serves to intensify the gathering gloom and eventually to throw the stage into complete obscurity while alterations are made in the scenery. In addition, the green colour occasionally gives valuable assistance by accentuating the red hues of the rising sun and the weird dawn preceding the deluge.

Occasionally the sudden flashing out of a series of lamps round the stage has been utilized in spectacular performances to dazzle the audience and prevent their observing changes made on the stage. A severe and sudden dazzle of this kind is not a method one would recommend on physiological grounds, but the gradual increase in intensity, and the employment of contrast used to obscure the stage in this case, seems a more legitimate device, and was not so utilized as to offend the eyes.

The spectacular exhibitions representing the San Francisco Earthquake, and the fleet of battleships off Dover, were also interesting examples of the use of light for the production of special effects. In the former case the setting of the sun, the gathering darkness, and the lights of San Francisco in the evening, were well represented, and the earthquake and fire following realistically reproduced. Ultimately, one saw the shattered town in the grey dawn and the falling rain.

The twilight and the gradual lighting up of the twinkling lights on the battleships were also cleverly managed, the latter, of course, being represented by tiny electric lights.

The ingenious exhibit of "bewitched sculpture" was, again, an instructive illustration of the utilization of the play of light and shadow. Embossed pictures were illuminated alternately by either of two screened lights placed on the right and left respectively. The

outlines in the pictures were of such a height that certain sections of it which were brought into prominence when the right - hand light was employed, were thrown into obscurity when the left-hand light was on, and an entirely different total effect produced. In this way contrasts entitled "Youth and Age," &c., could be produced by the changing light, or an apparent change in altitude repeated in rapid succession could be made to give the effect of movement.

The entertainment which goes by the name of the Red Man Spectacle again relied upon the imitation of natural conditions and the varying illumination of dawn and twilight; an attempt was made to represent the tribal life of the Sioux Indians, their camping out at night and breaking up of the camp at dawn, followed by a hymn of welcome to the rising sun. In connexion with the article on 'The Worship of Light' by Dr. M. Gaster in the June number of *The Illuminating Engineer*, it is interesting to notice here one instance of a community who still retain a form of worship of the heavens and of the sun as the origin of light.

It is also to be noted that the reproduction of the Black Hawk massacre is arranged to take place in the evening—an illustration of the well-founded convention which couples the hours of darkness with insecurity and danger.

In all these spectacular exhibits, it may be pointed out, recourse was invariably had to screened or concealed lights such as did not offend the eye. It was realized, too, that the strong illumination of the objects exhibited, amid relatively dark surroundings, was but natural and legitimate stage-craft, which served to hold the attention of the audience. These considerations might profitably be borne in mind by shopkeepers and others who do not always realize the folly, from a psychological standpoint, of placing light sources between the eyes of the observer and the object viewed.

Lastly, some reference may be made to the display of a working coal mine, which seems to bring home the hardships of a miner's life, and the difficulty of providing any but a dim illumination to aid him in executing his work. Naturally the grimy, dark surroundings, which reflect but little light, give a gloomy impression even when sources of sufficient intensity are available. Among the many hardships endured by the miner there are few defects in his conditions which are more unfortunate than this lack of light. It may be that no artificial means can compensate for the lack of sunshine, but the maintenance of an adequate standard of artificial illumination would certainly mitigate this defect.

Electric Lamps for Railway Signals.

A WRITER in a recent number of *The Electrical Engineer* refers to the special value of electric light for railway signal lamps. In addition to the ease with which lights in inconvenient places can be supplied, he lays special stress upon the fact that coloured lights on railway signals usually consist of small enclosures, the lens of which readily becomes coated with a film of soot when oil lamps and flames are used.

In addition he points out that :—

1. Electric glow lamps cannot be extinguished by a gale of wind.
2. They are unaffected by frosts and weather conditions.
3. Electrical energy can be instantly and automatically applied on the approach of fog or of unexpected darkness.
4. Lamps are controllable from a distance and the services of lamp lighters are not needed.

It may also be noted that carbon lamps are generally preferred, because the 8 candle-power light is considered sufficient, and under these conditions carbon filament lamps are usually more economical than metallic filament lamps, only procurable in relatively high candle-power units. In addition the possibility of lamps failing owing to vibration, though capable of being provided against, requires consideration; for the same reason short and stout filaments are preferable to long and thin ones, and the author also recommends that lamps should be hung from a flexible cord rather than rigidly fixed.

The Testing of Tungsten Lamps and the Theory of the Flicker Photometer.

By J. S. Dow.

A recent contribution by Mr. Lancelot Wild (*Electrician*, July 16th) contains a suggestion which, if confirmed by other observers, is a somewhat interesting illustration of the complexities of modern photometry. Mr. Wild has compared a tungsten lamp with a carbon filament one, the lamps being run at about the ordinary efficiency in each case, by the aid of a flicker photometer, and also by means of instruments depending on the principles of "equality of brightness" or "contrast"; he finds that the candle-power of the tungsten lamp apparently comes out 6 per cent lower when the flicker instrument is used than when tested by a photometer of the ordinary variety.

It may perhaps be suggested that this difference is not, after all, of very serious consequence from the practical standpoint. As a matter of principle, however, and especially on account of its apparent bearing upon the issuing of standards for the photometry of tungsten lamps, such a difference cannot be disregarded. For instance, if Mr. Wild's experience is general, a standard tungsten lamp prepared by reference to the pentane lamp might be found to differ considerably from one prepared by comparison with a carbon filament standard; and even supposing the latter method was adopted, the result might again be different according as the flicker photometer or a photometer of the ordinary variety were used in making the test.

That some difficulty has been occasionally experienced in reconciling the values of incandescent standards for use in the photometry of tungsten lamps prepared in different laboratories seems to be borne out by experiences in several quarters. Mr. Wild mentions that the value of a standard prepared by him differed appreciably from that given by Mr. Paterson of the National Physical Laboratory, and the writer has been informed from another source that standardized tungsten lamps, when submitted to test at various laboratories, were returned as having a distinctly different candle-power in each case. It may be noted that the National Physical Laboratory are at present devising a method of avoiding the difference in colour between the tungsten and carbon lamp by comparing "in cascade" a series of lamps of graded efficiency and colour, instead of comparing the ordinary tungsten and carbon lamp directly against one another. Quite recently, too, Mr. Cady has published an account of a different method which it is proposed to use at the Bureau of Standards (*Electrical World*, July 22nd, 1909). According to this plan the colour of the light illuminating both sides of the photometer-screen is made the same by inserting a special glass between one of the lamps and the photometer.

If such different methods of dealing with the colour differences between such illuminants as the tungsten and carbon filament lamps are introduced it would not be altogether surprising if some divergence in the results obtained were experienced, and there does seem a need for agreement on a common method of testing. Apart from the differences in the judgment of individual observers, when undertaking a comparison of this kind, it seems highly probable that appreciable differences can be introduced in the case of a photometer of the "equality of brightness" pattern owing to the so-called "yellow-spot effect." In consequence of the physiological peculiarities of the retina, the observer may obtain different

results according to the size of the image of the photometrical surface received upon it Thus he may find that if he alters the distance of his eye from the photometer, the point of balance changes ; he may find, too, that two instruments having photometrical surfaces differing in size but otherwise identical will yield different results. As an illustration of the differences which the author has found can be produced in this way we may take Fig. 1, to which he has referred in a paper before the Physical Society two years ago ; Mr. Wild (See letter, *Electrician*, August 16th, 1907) seems to confirm this result, qualitatively at according as the flicker wheel was in motion or stationary.

Yet, as Mr. Abady in his recent letter (*Electrician*, July 30th) justly observes, it is not strictly logical to assume as yet that either instrument gives a correct value. The flicker photometer may be found to yield results, which are to some extent arbitrary for the comparison of heterochromatic lights, but the same would seem to be true for a photometer of the equality of brightness pattern

This question of the correct method of comparing sources of different colour seems now to demand more detailed attention than in the days when few

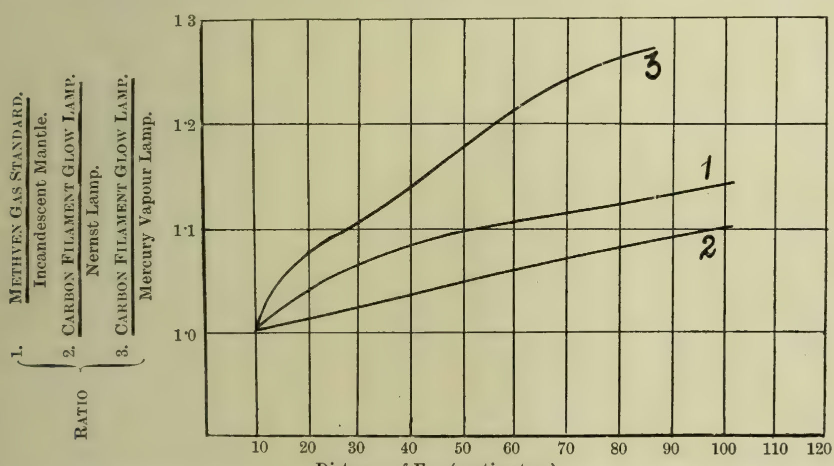


Fig. 3.—Showing influence of distance of eye from the blocks on the readings of a Joly Photometer, when various heterochromatic sources are compared.

N.B.—The apparent ratios of the candle-powers of the sources with the eye at a distance of 10 centimetres are reduced to unity in each case, and all other readings in the same proportion.

all events. Naturally this effect may be expected to manifest somewhat differently in the case of different observers.

The question may well be raised whether similar effects influence the flicker photometer. Even if this be not the case, however, it seems clear that if the reading of an ordinary photometer may vary in the above manner, it must sometimes lead to conclusions differing from those suggested by a flicker instrument. Mr. Lauriol has recorded difference of the order of 20 per cent when comparing various types of incandescent lamps (*Bull. Soc. Int. des Electriciens*, November, 1904) with a flicker photometer, sources differing markedly in the colour of the light yielded, were available. At one time it was merely an interesting ground for controversy, and it is, perhaps, even to-day regarded by many as a somewhat academic subject for discussion. At the same time, as a matter of principle, it is desirable that the matter should be cleared up as far as possible, and that some general agreement should be reached as a common policy.

In comparing the results obtained by the flicker and equality of brightness photometers one finds oneself in need of a deeper knowledge of the physiological basis of the former type of instrument. We can, however, apply several

tests with the object of deciding how far the principle underlying both types is the same. One obvious line of attack is to compare the readings of people with abnormal colour-vision when using different types of photometers. As the writer has pointed out, however (*Gas World*, April 11th, 1908), this has not yet led to any very conclusive results, chiefly because so many varieties of colour-blindness seem to exist. The most recent investigations at the Reichsanstalt on this point seem to suggest that, at any rate, many people who, through defects in colour-vision, obtain peculiar results with photometers of the equality of brightness pattern will also do so with flicker photometers.

A more hopeful method of examination is to attempt to ascertain how far flicker photometers are subject to the physiological pecularities of the retina, which are usually ascribed to the theory of the rods and cones. (For a brief summary of this theory and its application to colour-photometry, see this journal, Vol. I., 1908, p. 155.)

The Purkinje effect is ascribed to the struggle for predominance between these organs as the illumination increases, and the distribution of rods and cones over the retina also seems to explain very satisfactorily the yellow-spot effect. In a paper before the Physical Society in 1906, to which reference has been made, the author gave a few instances of the application of this theory to heterochromatic photometry, and made some attempt to ascertain whether flicker photometers were subject to these physiological effects. These experiments have been supplemented by others since the date of this paper, and it appears that the flicker photometer is at any rate much less distinctly influenced by the yellow-spot effect than ordinary photometers: this conclusion seems also to have been reached by Mr. Wild (*Electrician*, August, 16th 1907). The method of investigating the Purkinje effect utilized by the author on that occasion was open to objection in several respects, chiefly because the flicker sensation, as a means of photometric balance, was not utilized, owing to difficulty in making a judgment at the extremely low order of illumination. As a result of other experiments of a more satisfactory nature, however, he is satisfied, as far as his own experience is concerned, that the influence of the Purkinje effects on a flicker instrument studied was apparently less marked than on photometers utilizing the principle of "equality of brightness." A similar experience was recorded by Mr. P. S. Millar at the discussion following a lecture by Dr. Steinmitz before the Illuminating Engineering Society of New York in December, 1906. Mr. Millar had attempted to compare a carbon filament glow lamp with a mercury vapour lamp at a series of different distances on a long photometric bench. He used both the Lummer-Brodhun and the flicker photometer, and found that, whereas the results in the latter case were very consistent, in the former case they progressively changed by about 30 per cent as the illumination of the photometer was decreased, and in the direction which the Purkinje effect would lead us to anticipate.

There appears, therefore, some ground for supposing that the ordinary consequences of the behaviour of the rods and cones is much less marked in the case of the flicker instrument than in the case of photometers of the equality of brightness or contrast patterns. In making this suggestion the writer, of course, is well aware, that a much more complete investigation by a series of different observers is really necessary before any final conclusion can be arrived at.

The above two facts, however, namely, that the flicker photometer seems to be less subject to the Purkinje and yellow-spot effects than photometers of the equality of brightness and other patterns, naturally lead us to suppose that the struggle for the predominance of rods and cones is in some way lessened in the case of this instrument, and that one of these sets of organs therefore exerts relatively less influence in comparison with the other. A suggestion to the effect that the reading of flicker-photometers may depend *only* on the action of the rods

has, indeed, been thrown out by Mr. Wild in his recent letter to *The Electrician* (Aug. 6th, 1909). This suggestion, however, will not bear close scrutiny. For one thing the flicker photometer is of course quite convenient to use, and indeed at its best, at somewhat high illuminations when the *cones* are believed to be predominant organs; and it is known to be less effectual at very low illuminations—when the rods are predominant. Also under ordinary conditions we can look straight into the field of view of the flicker photometer and therefore utilize the central part of the retina quite satisfactorily, though in this part of the retina the cones only are believed to exist.

The writer, however, is inclined to suggest a different explanation based on a somewhat similar idea. Granted that the cones and rods exercise distinct functions, and probably achieve vision by a somewhat different process, we can imagine that the sum-effect in the flicker photometer consists of a flicker due to cone-action and a flicker due to rod-action taking place simultaneously. When either set of organs is inoperative we should then have only rod flicker or only cone-flicker respectively. Thus at very low illuminations, when the cones go out of action and the central part of the retina becomes practically blind, we must have only rod-flicker, which can only be perceived by bringing the peripheral region of the retina into play by looking at the flicker obliquely.

But there is reason to believe that, in addition to their distinct action from the cones as regards the perception of light and colour, the rods also differ in the "last" of the luminous impression received on the retina. It seems possible that an impression received only through the rods remains active for a longer period than one received through the cones, and that therefore a speed of the flicker photometer which would be quite satisfactory for cone flicker might be high enough to blend the impression received through the rods. We should thus obtain a flicker due to the action of the cones, and superimposed over this *a steady luminous impression* due to the impulses received through the rods, which succeed each other too rapidly to give rise to any flicker sensation.

It will be seen that this would serve to account very well for the apparent fact that the retinal colour effects, due to the struggle between the rods and cones, are so much less marked in the case of the flicker photometer, for it might well be that under the normal conditions of use the speed was too high for the rods to affect very materially its readings. It also seems to be in accordance with the well-known fact that the "critical speed" of a flicker photometer increases with increasing illumination.

There is, moreover, other evidence in support of this suggestion. Dr. T. C. Porter (Proc. Roy. Soc. London, Vol. 70, p. 313, 1902), in a very interesting and painstaking series of researches, established a relation between the duration of impressions received by the eye and the intensity of illumination. He stated this in the form :— $n = k \log. I + p$ (where n = the number of revolutions per second when flicker vanishes, k and p are constants, and I is the illumination of a rotated sector-disc).

It is interesting to note that at an illumination of about 0·25 candle-meters the slope of the curve illustrating this relation abruptly alters, and the constant k undergoes a corresponding diminution. Now this order of illumination is practically identical with that at which, in the case of the author's eye, the Purkinje effect, for small retinal areas, suddenly becomes much more marked. It is also the order of illumination at which a very sudden alteration occurs in visual acuity (see *Illuminating Engineer*, April, 1909, p. 237); it is, in fact, the point at which the cones seem to go out of action, and to be replaced by rod-vision. This suggests, therefore, that the transition from cone-vision to rod-vision is accompanied by a marked increase in the "last" of a luminous impression.

In the present article the writer cannot dwell on many other interesting physiclogical facts which seem to

favour this suggestion. Reference may, however, be made to one curious and interesting point brought out by the researches of Shelford Bidewell, von Kries, and others. These observers have found that, when a coloured object is rotated before the eye, under certain conditions a "recurrent image" is visible. This means that a second ghostly image of the object can be seen following behind at a fixed interval, and apparently corresponding to the image received and retained by the eye for a different period of time. Now there is evidence which suggests that this latter image is perceived through the rods while the main image is connected with the cones. For instance, the recurrent image is seen most readily when light of a greenish character (to which the rods are most sensitive) is used; on the other hand, it appears not to be seen at all in the case of red light, to which the rods are practically insensitive. Some observers have also stated that the recurrent image cannot be seen when only the central portion of the retina, where there are no rods, is used.

Yet other physiological evidence is available. For instance, the quality of flicker of a very low illumination seems to be of a peculiar violent character, and quite different to the fine trembling sensation which we usually observe in the flicker photometer at high illuminations. The writer, therefore, is inclined to suppose that this violent quality of flicker is associated with the action of the rods, while the fine trembling variety is associated with the cones. In support of this contention it may be pointed out that the violent quality of flicker is most readily observable at slow speeds, and at very low illuminations, and that it is best seen under these conditions by *indirect vision*, vanishing when we look straight at the object. At high illumination, however, as the speed is increased, a fine trembling variety is found to be perceived most readily by using the central portion of the retina; indeed, if the speed be high enough it can only be perceived by using this central part of the retina where the cones predominate.

All this has suggested to some physiologists the view that an impression received through the rods and the visual purple is received more gradually and retained for a longer period than one received through the cones; it thus furnishes some support for the above theory of the part played by both organs in the flicker photometer.

On the above theory we might expect flicker instruments and photometers of the equality of brightness or contrast type to give results agreeing very well with each other at high illuminations, when the cones are the predominant organs. At lower illuminations, however, when the struggle between the rods and cones is in progress, some differences in their readings might be expected; but, as stated above, the readings of both instruments must probably be considered as to some extent arbitrary when different coloured sources of light are concerned.

The writer is conscious, however, that additional accumulated data are needed before a point of this kind can be regarded as established. For instance, it is clearly necessary to undertake experiments with a large number of observers. In addition, it must, of course, be realized that the basis of this problem is essentially physiological, and can therefore only be adequately examined by physicists interested in photometry and physiologists working in mutual co-operation.

In this connexion it may, for instance, be mentioned that many points in connexion with the rod and cone theory are still the subject of differences of opinion among physiologists (see Edridge Green, *Illuminating Engineer*, March, 1909, p. 210), although the phenomena on which the theory is based seems to be well authenticated. It may be hoped, however, that these remarks will have a certain suggestive value, and will lead to a more complete investigation into these problems in the future.

High Duty Gas Lighting.

BY THOMAS HOLGATE, M.Inst. C.E., F.C.S.

(*Continued from p.* 538.)

FOLLOWING the plan of applying the foregoing principles to the elucidation of data respecting incandescent lighting, we will now take a record of experiments upon ordinary upright burners, and which give results that superficially indicate that a lower quality of gas is as good or even better than that of a higher grade. The unreliability, or rather the limited applicability, of that view can only be shown by close examination, thereby removing step by step misconceptions that have existed, and in too many cases still continue to exist.

The experiments referred to were for the purpose of ascertaining the results when coal gas was used, and when carburetted water gas was used, and were carried out by Drs. Schmidt and Leybold for the Photometric Committee of the German Association of Gas Engineers. The burner used was an ordinary Welsbach with clear chimney. The air holes were 0·275 in. diameter, and were provided with an air regulator. The five holes in the gas nipple were enlarged so as to allow at 1 in. pressure, 3·71 cubic feet of coal gas per hour. This series of tests was called A, another burner jet or nipple being substituted in the burner for the tests, series B. In all cases the air supply was adjusted to give the maximum illuminating power. The report states that the larger the percentage of carburetted water gas added the greater the consumption required to give the highest illuminating power, and, on the other hand, the greater the amount of carburetted water gas added the higher the lighting power obtained. The gases employed had the following properties given in Table VIII.

The right hand half of this table and the averages have been computed for the purpose of making clear the large differences that exist in the make up of the coal gas and carburetted water gas in each series, and that although the average of series A is not much different to the average of series B, yet in the several components there are important divergences that will have effect in the mixtures containing the various percentages of carburetted water gas. The difference in density of the two classes of gas is well marked. The most important is the difference in the origin of the heat; in the coal gas that from hydrogen largely preponderates over that from carbon, whilst in the carburetted water gas that from carbon equals the gross heat from hydrogen, and distinctly exceeds the net. Those figures do not differentiate

TABLE VIII.

	Series	Specific gravity relative to		B. Th. U. per cubic foot at 30″ and 60° F.				B. Th. U. per cubic foot due		
		hydrogen	air	Gross	Net	Difference	Difference per cent	to carbon	to hydrogen Gross	to hydrogen Net
Coal gas	A	5·68	0·393	630	559	71	11·27	193·9	436·1	365·1
Carburetted water gas	A	9·6835	0·670	523	481	42	8·03	265·0	258·0	216·0
Average	A	7·682	0·5315	576·5	520	56·5	9·65	229·45	347·05	290·5
Coal gas	B	5·4054	0·374	594	528	66	11·11	188·6	405·4	339·4
Carburetted water gas	B	8·715	0·603	547	502	45	8·23	270·6	276·4	231·4
Average	B	7·060	0·4885	570·5	515	55·5	9·67	229·6	340·9	285·4

between carbon in the form of carbon monoxide and in hydrocarbons, as no analyses are given. This information would have been valuable, because carbon in the former state of combination requires much less air for combustion than it does in the latter. But as all carburetted water gas contains a large proportion of carbon monoxide the tendency would be for the carburetted water gas to require less air in proportion to heat developed. In the tests made the light was ascertained when using each gas separately, and with mixtures in varying proportions within each series A and B. The whole of the figures would occupy too much space, but the more definite results obtained therefrom by diagram are given subsequently. The figures for each distinct gas are given in Table IX.

Thus we have with the lowest pressure acting on the same sized orifice delivered to the burner the greater amount of potential energy of gas, and as the higher quality of gas is the one that requires more air for its combustion, the inequality above shown is further accentuated. This is doubtless the primary factor in the explanation of why in the above table the lowest quality of gas appears to give the best results. That explanation must now be given as far as possible in detail.

Fig. 3 gives curves showing the net heat in B.Th. units required to give one candle when burnt in series A, at the several rates per hour. The outstanding feature is that the apparent efficiency of the coal gas increases as the quantity diminishes, whilst that of the carburetted water gas rises as the

TABLE IX.

Gas consumed per hour in cubic feet.	Coal Gas A.			Coal Gas B.			Carburetted Water Gas A.			Carburetted Water Gas B.		
	Pressure, inches of water.	Lighting power, English candles. Total.	Lighting power, English candles. Per cubic ft. of gas.	Pressure, inches of water.	Lighting power, English candles. Total.	Lighting power, English candles. Per cubic ft. of gas	Pressure, inches of water.	Lighting power, English candles. Total.	Lighting power, English candles. Per cubic ft. of gas.	Pressure, inches of water.	Lighting power, English candles. Total.	Lighting power, English candles. Per cubic ft. of gas.
3·71	1·0	70	19·0	1·0	69	18·7	1·4	66	17·7	1·7	72	19·4
3·88	1·1	69	17·7	1·2	73	18·7	1·5	74	19·1	1·8	78	20·0
4·06	1·2	65	15·9	1·3	72	17·7	1·6	80	19·6	2·0	88	21·6
4·24	1·3	65	15·3	1·4	66	15·5	1·7	86	20·4	2·2	92	21·8
Average— 3·9725	1·15	67·25	16·975	1·225	70	17·65	1·55	76·5	19·2	1·925	82·5	20·7
4·41	—	—	—	—	—	—	1·8	91	20·7	2·2	92	20·9
B. Th. U. net per candle	$\frac{559}{16·975} = 32·93$			$\frac{528}{17·65} = 29·92$			$\frac{481}{19·2} = 25·0$			$\frac{502}{20·7} = 24·25$		

Taking the same average consumption of 3·9725 cubic feet per hour, we have the following relation between the gas pressure and the potential energy in B.Th. units net, delivered to the burner thereby.

quantity used increases. Reference, however, to Fig. 4, which represents the tests series B, shows that this is not confirmed; the efficiency of the carburetted water gas B falls off above 4·2 cubic feet per hour,

Series A.			Series B.			
Sp. gr. (air=1).	Pressure inches.	Net B. Th. Units.	Sp. gr. (air=1).	Pressure inches.	Net B. Th. Units.	
0·393	1·15	559	0.374	1·225	528	Coal gas
0·670	1·55	481	0·603	1·925	502	Carburetted water gas

and the efficiency of the coal gas B becomes almost fixed at about 3·7 cubic feet per hour. How these two series stand related is seen in Fig. 7, which indicates that the efficiency of the four gases would have been approximately the same at about 3·6 cubic feet per hour.

This behaviour shows that another factor is here at work, besides the quality of the gas. Fig. 3 gives curves that are very instructive. With 10 per cent of carburetted water gas contrary to the pure coal gas, the efficiency *rises* with increased consumption to a small extent, when it

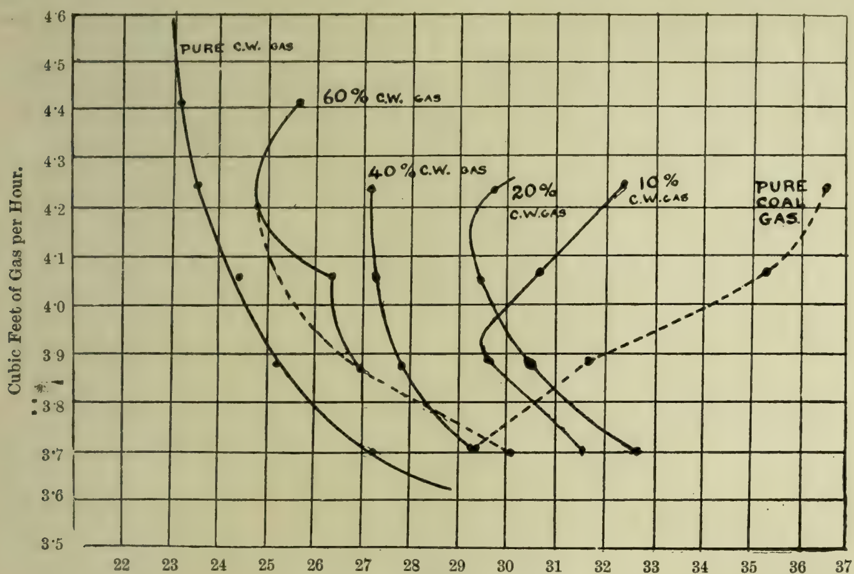


FIG. 3.

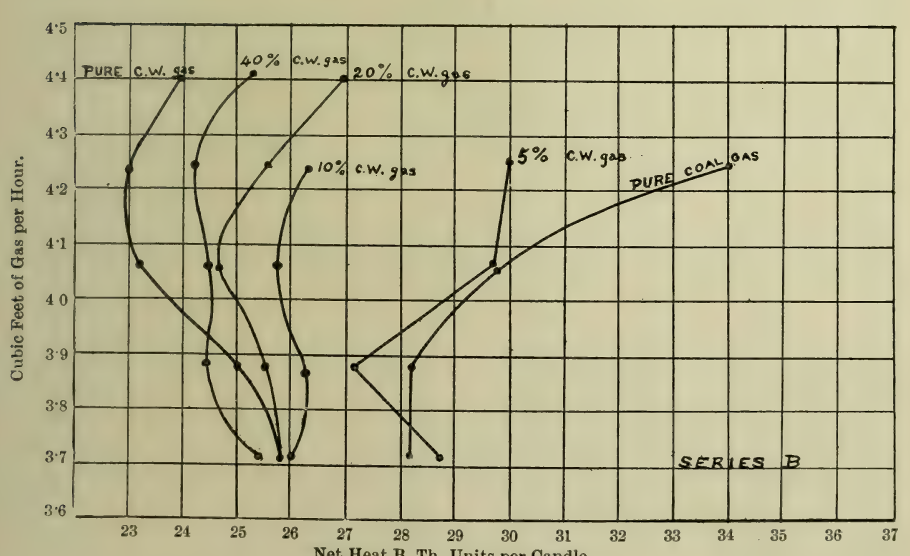


FIG. 4.—Gases of Series B.

suddenly reverts from dissimilarity to similarity. In a less rapid way the same fact occurs with the other mixtures, the 60 per cent carburetted water gas, showing two such reversions. Fig. 4 shows this curve relationship in a less degree, and this is no doubt due to the fact that in series A the gases differ more than they do in series B. A has 559 and 481 B.Th units net for coal gas and carburetted water gas respectively, or a difference of 78, whilst series B has 528 and 502 respectively, a difference of 26. Thus the contrast between the first pair of gases is three times that of the second pair. The effect of the great similarity in net B.Th. units of the coal gas and carburetted water gas in series B is to show a rate of consumption of about 3·7 cubic feet per hour, which is almost equally suitable for four different tests, yielding a common efficiency of 25·4 to 26 B.Th. units per candle.

Figs. 5 and 6 combine the data of Figs. 3 and 4, in fresh forms, to show what is the disturbing factor. Fig. 5 gives curves that represent the efficiency in net heat of British thermal units per candle as abscissæ, and percentage of net heat of gas due to carbon as ordinates. It will be seen that at the top of each curve stands the carburetted water gas, and at the other extremity the coal gas. The two curves A and B are in the main confirmatory, they show that the higher the percentage of heat due to carbon the greater the efficiency. The curves are formed by points which mark the highest efficiency, at the several rates of consumption tested, and there is therefore nothing to prevent the curves A and B reverting at a point which would have been

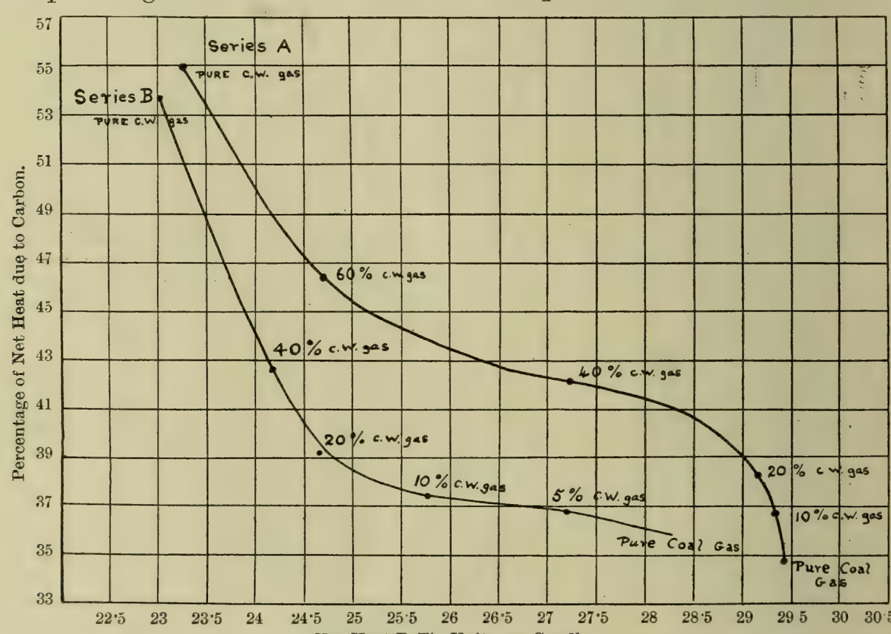


FIG. 5.

determined by a smaller consumption of coal gas. Such a possibility and tendency is evident with curve A. Fig. 6 shows that consistently with Fig. 5 the efficiency rises with the actual amount of heat due to carbon. Carburetted water gas A is almost equal in efficiency to carburetted water gas B, the difference in their carbon content being very small. The highest efficiency coincided when using 4·5 cubic feet of carburetted water gas A as against 4·2 cubic feet of carburetted water gas B. With a greater

consumption of the latter gas the efficiency fell. Practically the tests serve to determine the range of suitability of the burner, at the same time as the efficiency of the gas. The burner was capable of dealing equally well with the following quantities :—

Using carburetted water gas A, under 1·8 in. pressure, passing 4·5 cubic feet of gas × 481 = 2165 B.Th. units per hour sp. gr. of gas 0·670.

Using carburetted water gas B, under 2·2 in. pressure, passing 4·2 cubic feet of gas × 502 = 2108 B.Th. units per hour sp. gr. of gas 0·603.

Using carburetted water gas B, under 2·1 in. pressure, passing 4·14 cubic feet of gas × 502 = 2078 B.Th. units per hour sp. gr. of gas 0·603.

If we look closely at Fig. 4, it seems as though it is quite possible that a more exact adjustment of gas, say to 4·14 cubic feet, would have given a higher efficiency, and that assumption has been included in the above statement, which indicates that the burner was able to deal best with 2078 B.Th. units per hour from carburetted water gas B. Now as 4·14 cubic feet of carburetted water gas B sp. gr. 0·603, issued under a pressure of 2·1 in., as against 4·5 cubic feet sp. gr. 0·670 under 1·8 in., it is clear the former must have emerged through a smaller

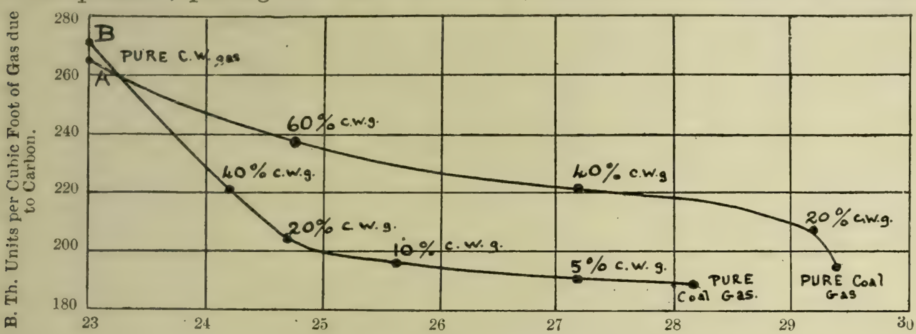


FIG. 6.

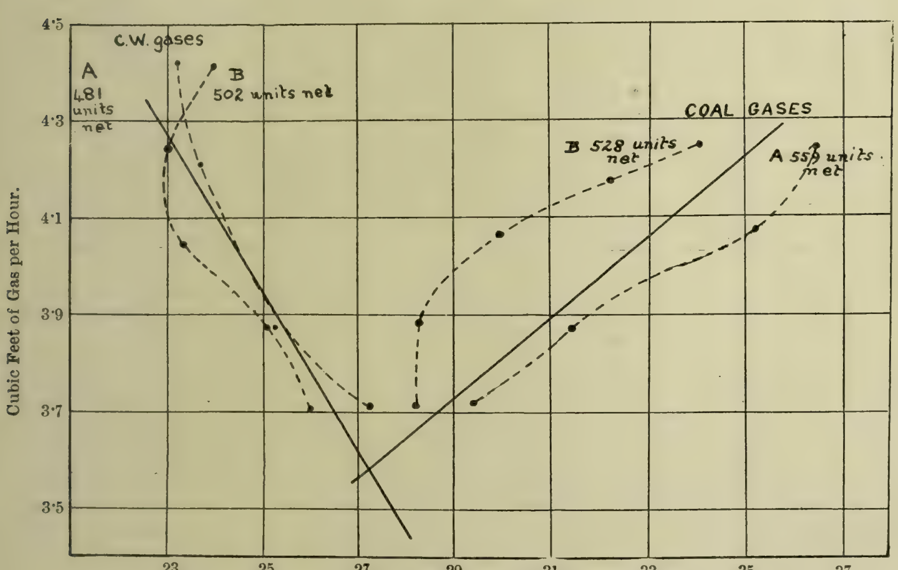
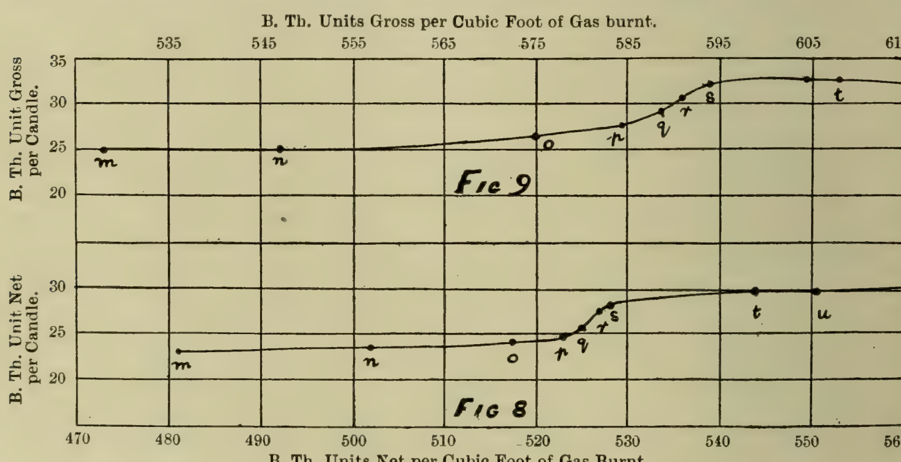


FIG. 7.

orifice and with greater velocity, enabling it to take in at the mixing bulb a larger proportion of air, sufficient with 2078 B.Th. units to do the work requiring in the case of carburetted water gas A, 2165 B.Th. units.

Further, as coal gas is known to require more air per cubic foot than carburetted water gas of the same calorific value, we must conclude that a smaller quantity than 2078 B.Th. units (net) was the limit of capacity of the burner when using coal gas. This is shown by Fig. 7. It would appear as though the coal gas was too rich for the particular air feed of that burner, for 3·7 cubic feet of B=528 (net) gave an efficiency of 28·25, against the same volume of gas A=559 (net) an efficiency of only 29·4. 3·7×528=1954 B.Th. units (net). 3·7×559=2068·3 B.Th. units (net). Comparing these figures with those above, we see the burner was capable of dealing with more units of heat from the carburetted water gas than the coal gas and with greater efficiency. The Fig. 7 indicates that if the experiments had been extended to a smaller consumption of coal gas, a point would have been reached, about 3·58 cubic feet per hour, where each kind of gas, the average of the coal gases and the average of the carburetted water gases, would have been equally efficient as to the heat units utilized, or equally inefficient as to total light obtained. In the case of coal gas 3·58×543=1944 B.Th. units (net) per hour, and in the case of carburetted water gas 3·58×491=1758 B.Th. units per hour. In the former the defect appears to be at this rate of gas consumption, an insufficient air feed, and in the latter a diminution in the size of the flame, causing it not to fit the mantle in the way to obtain highest efficiency consistent with a due total lighting power.



Figs. 8 and 9 embody the tests as a relation of the efficiency towards the net and gross calorific values of the gases burnt respectively, and the curves show an interesting feature at the points, *p*, *q*, *r* and *s*.

Figs. 5 and 6 have shown that the efficiency upon the whole rises with the carbon content of the gas, but it is necessary to discriminate between carbon present as monoxide and as hydrocarbons. The reason for this is twofold, (*a*) the different amount of heat liberated per atom of carbon in relation to the air required for combustion, and (*b*) the precedence in this respect of carbon monoxide over hydrogen, and the latter over the carbon in hydrocarbons. In blue water gas all heat from carbon is provided by carbon monoxide, but in carburetted water gas we have also the hydrocarbons that are in coal gas. The result is that the essential disparity between carburetted water gas and coal gas is the higher percentage of the carbon monoxide of the former. The

gas employed and the efficiency thereof per candle is dissected as to carbon and hydrogen in the subjoined table :—

TABLE X.

Distinctive letter.	Series of expt.	Percentage of Carburetted water gas.	British thermal units per cubic foot. Gross.	Net.	Net due to Hydrogen.	Due to Carbon.	Net B. Th. U. per candle.	Provided by the combustion of Hydrogen.	Carbon.	Percentage of net heat due to Carbon.	
m	A	100	523	481	216	265	23·2	10·42	12·78	55·	Section one.
n	B	100	547	502	231·4	270·6	22·8	10·51	12·29	53·8	
o	B	40	575·2	517·6	296·2	221·4	24·2	13·85	10·35	42·	
p	B	20	584·6	522·8	317·8	205·9	24·6	14·95	9·65	39·	Section two.
q	B	10	589·3	525·4	328·6	196·8	25·7	16·07	9·63	37·	
r	B	5	591·65	526·7	334·0	192·7	27·1	17·2	9·90	36·	
s	B	none	594·0	528·0	339·4	188·6	28·2	18·13	10·07	35·	
t	A	20	608·6	543·4	335·3	208·1	29·2	18·02	11·18	37·	Section three.
u	A	10	619·3	551·2	350·2	201·0	29·5	18·75	10·75	36·	
v	A	none	630·0	559·0	365·1	193·9	29·4	19·20	10·20	34·	

The following statement gives the heat of combustion of each cubic foot of carbon vapour in the several states of combination, the one for unsaturated hydrocarbons being the average of one-third by volume of benzene and two-thirds ethylene. The cubic foot of hydrogen yields 325 B.Th. units gross and 272 net. The latter, or the net calorific value of the gas used, is probably the active figure in incandescent lighting, the Diagrams Nos. 8 and 9 appearing to support what is the generally accepted view.

In unsaturated hydro carbons.	In methane.	In carbon monoxide.	Hydrogen.	
470	358	323	272	B. Thermal Units.
2	2	1	1	Relative vols. of air.
235	179	323	272	Heat liberated per unit vol. of air.

Table X. can now be interpreted. First, the third section does not represent experimental values so weighty as those preceding, which do approach a limit. Diagrams 3, 4 and 7 show that by a further extension in the direction of smaller consumption of gas a higher efficiency was possible. Why this happened is seen by comparing the figures for hydrogen heat and carbon heat with those of the first section. The carbon heat of the third section was less than that of the first section, but more than that of the second section. As the carbon of the first section was more largely that of carbon monoxide, which requires the least air in proportion to heat liberated, it is probably reasonable to accept that fact as the principal cause of the superior efficiency.

It is also noteworthy how much more heat from hydrogen accompanies the heat from carbon in the last lines of the table than in the first. This fact is expressed by the last column, namely, the percentage of net heat due to carbon. Perhaps the most interesting section is the second one, which on Diagram 8 appears to mark a distinct step in the curve. The points *p*, *q*, *r*, *s*, coincide with an almost identical consumption of carbon, ranging from 9·63 to 10·07 B.Th. units per candle, but with a variation of heat from hydrogen from 14·95 to 18·13. This section appears also capable of explanation, by the general statement that if sufficient air be supplied, almost equal results will be obtained by a given expenditure of heat from either kind of gas. These experiments do not, however, exclude the possibility of the efficiency being affected also by flame temperature, nor do the figures in Table X. exclude the possibility that the effect of heat from carbon may be in some way different to that from

hydrogen. There is, of course, a difference in the case of luminous flames, and the known high efficiency of gas rich in carbon, where an abundant air supply is furnished to incandescent burners, justifies us in regarding the latter as an open question. Fig. 5 shows in these tests a wide range of net heat due to carbon, namely, from 35 to 55 per cent. The gas of the Gas Light and Coke Co. usually has 37·45 per cent, the east end of London 36·37 per cent, and the gas of Edinburgh 43·8 per cent. These figures have also a bearing upon the tests of the Keith lamp given in the former part of this article.

The incidence of carbon monoxide in securing the highest efficiency justifies a recapitulation of the ways in which that substance operates. First, in supplying the most heat in proportion to air used, and second, the furnishing of the highest theoretical flame temperature; and these two properties operate in a twofold way. First, they facilitate the operation of the mixing tube of the burner; and secondly, provide a liberal increase of illuminating power due to the greater incandescense of the mantle.

It is hoped that sufficient has been said to show the principles upon which the recent developments of gas lighting have proceeded, and by implication that there are further possibilities in store.

Perfuming Mixed Gases.

FROM *The Gas World* we learn that an interesting question has been the subject of discussion in Dutch gas circles, namely the necessity for providing so-called "mixed gases," which are comparatively odourless, with some degree of smell; otherwise there is a danger of an escape of gas not being readily recognized.

Various substances, such as mercaptan and carbylamine, were proposed, but many of them, while owning a pronounced odour, are somewhat poisonous. From a lively recollection of the "perfume" of the latter substance, the writer would be inclined to suppose that there would be no lack of promptitude in making known an escape of gas in which it occurred as a constituent.

It was also suggested, however, that no smell was entirely satisfactory as a means of detection, and that the gas should be provided with such constituents as would cause any one inhaling it to sneeze or shed tears!

In Amsterdam, however, such rigorous measures do not seem to be considered necessary, and carburation with petroleum-benzene seems to be regarded as meeting the case.

The Third Annual Convention of the Illuminating Engineering Society, U.S.A.

WE note that the third Annual Convention of the Illuminating Engineering Society in the United States will take place in the main auditorium in the Engineering Societies building in New York City on the 25th, 26th, and 27th of September. It will be observed that the Convention is on this occasion to last three days instead of two, as was previously the case, but only one gathering will be held on each day instead of two.

It is stated that exhibits of special educational value will be shown on this occasion. In addition the Hudson-Fulton Celebration will be taking place while the Convention is in progress, and the Celebration will be accompanied by special spectacular lighting. We observe that the general Convention Committee is of a very representative character, and has as its chairman Mr. E. L. Elliott, the editor of our contemporary *The Illuminating Engineer* of New York.

Public Lighting.

[Report of the Deputation appointed by the Streets Committee of the Corporation of London to study the lighting of continental cities.]

(*Continued from p.* 528.)

Munich.

On arriving, the Deputation was received by the Director of Gas Lighting, and others, including the British Vice-Consul, William E. Soltau, Esq.

The number of electric arc lamps in Munich is about 900, supplied by direct current. Open lamps of the "Alba-Carbon" type are generally used, taking 450 and 270 watts. There are also 78 flame lamps, taking 300 watts. About one-half of the lamps are fixed upon standards at distances of about 200 ft. apart, the lamps being about 33 ft. above the pavement level in streets about 80 ft. wide. The flame lamps are placed at average distances of 160 ft., at a height of 33 ft. in streets about 70 ft. wide.

Centrally hung lamps are fitted with lowering gear, and in some of the widest streets as many as three arc lamps are suspended across the road on a single line.

The cost per annum per lamp for electric arc lamps, including interest on capital outlay, depreciation, and all other charges, was stated to be—for open lamps, about £29, flame lamps £27, the current being supplied by the Municipal authority.

Of electric glow lamps, there are 96 in use, metal filament lamps being generally adopted, of 28 candle-power, taking 55 watts.

They are fixed on central posts (three in each lantern), and also on brackets, the distances between the lamps being about 162 ft., at a height of 13 ft. in streets about 33 ft. wide. The cost per annum per lamp, including capital expenditure, depreciation, and all other charges, for metal filament lamps is £3 8*s*. 8*d*.

High-pressure incandescent gas lamps are not at present installed in Munich.

In the low-pressure gas lamps, Welsbach upright incandescent burners are used, consuming about 3½ cubic ft. per hour. The illuminating power was stated to be 72 candle-power, the lamps being fixed about 11½ ft. above the roadway at distances of about 60 ft. The cost of these low-pressure incandescent gas lamps, including interest on capital expenditure, depreciation, and all other charges, is £4 4*s*. 4*d*. per annum. The lamps are fixed upon side columns. The inverted incandescent gas lamp is being introduced, about 10 per cent. of the gas lamps being of this character.

Gas and electricity are made and supplied by the Municipal authorities.

Cologne.

The important streets of the City are lighted by centrally hung electric lamps, the open spaces by a combination of electricity and gas, as in Brussels, the minor streets mainly by incandescent gas lamps upon standards.

The total number of electric arc lamps in Cologne is 426, supplied by alternating current, both open and flame lamps being used. One half of the lamps are centrally hung, the others being fixed upon standards. The distance between the open lamps is 88 ft. to 115 ft., and between the flame lamps 121 ft. to 148 ft. The lamps are fixed at a height of from 26 ft. to 33 ft. in streets from 23 ft. to 148 ft. wide.

The cost per annum per lamp, including interest on capital outlay, depreciation, and all other charges, is for open lamps £11 5*s*. 6*d*. each; for flame lamps £9 6*s*. 3*d*. each.

The centrally suspended arc lamps are fixed about 30 ft. above the roadway, 110 ft. apart, and give a light

equal to about 1,300 candles each. The apparatus used for lowering the lamps is contained in a box 12 in. high, 8 in. wide, attached to the houses about 4 ft. from the pavement level.

By a simple arrangement the lamps are drawn aside over the pavement and lowered for trimming, &c., and on being replaced are lighted by automatic contact with the main wire. Owing to the daily examination during the trimming of the lamps, the danger to the public from defective wires is reduced to a minimum, only one accident having been reported since the lamps were fixed.

One hundred and seventeen electric glow lamps are used in the streets, of which 30 are carbon filament lamps, and 87 metal filament lamps. These carbon filament lamps are of 14 candle-power, and take about 50 watts each, the metal filament lamps are 28 candle-power, and take 32 watts. The lamps are fixed in groups upon columns about 100 ft. apart, at an average height of 11 ft. 6 in.

The cost per annum per lamp, including interest on capital expenditure, depreciation, and all other charges, is: for carbon filament lamps £2 14*s.*, metal filament lamps £2 4*s.* 2*d.*

There are only 10 high-pressure gas lamps in the streets of Cologne, and these are supplied direct from a compressing plant, and give a light of from 460 to 1,080 candle-power, but as they were stated to be purely experimental, no definite information could be obtained as to their value.

Incandescent gas lighting (low pressure) is largely used in the City, there being 192 miles of side streets in lighting, the lanterns being fitted with upright Welsbach mantles. The consumption of gas is about 4¼ cubic feet per hour, giving a light of 63 to 72 candle-power, the average height of the lamps above the roadway, measuring from the burner, being about 11 ft. 6 in. The lamps are placed about 65 ft. to 98 ft. apart diagonally, and are fixed partly on central columns and partly on wall brackets. The cost per annum, including interest on capital expenditure, depreciation, and all other charges, is: for lighting up to midnight, £2 11*s.* 8*d.*; all night, £3 5*s.* 3*d.*

The incandescent gas lamps (low pressure), although fixed in nearly all the streets of Cologne, are only used in the main streets after midnight, or when the electric light fails.

The Deputation was informed that the Municipality, which has control of the lighting and of the waterworks, makes a profit on these of about £150,000 a year in relief of rates. Electricity is also supplied by the Municipality.

The City is encircled by a ring street, which is lit by electricity, and during the summer months, when trees are in full leaf, incandescent gas lighting is also used.

Düsseldorf.

Düsseldorf, the capital of the district of that name, lies on the right bank of the Rhine at the influx of the Düsselbach. It has an area of about 19 square miles, with a population of about 252,000.

The Deputation inspected the lighting under the guidance of the Inspector of Electricity and other officials.

The City is lighted in a somewhat similar manner to Cologne—arc lamps on standards and centrally hung, supplemented by incandescent gas.

The total number of electric arc lamps in Düsseldorf is 334, of which 24 are supplied by alternating current, and 310 by direct current. Open and flame lamps are used, each lamp taking about 650 watts.

One hundred and forty-nine of these lamps are fixed upon standards and brackets, centrally suspended lamps to the number of 185 being used in narrow streets, the lowering gear being fixed to the sides of the houses in the same manner as in Cologne. Owing to the daily systematic examination during the trimming of the lamps, the danger from defective wires is reduced to a minimum.

The average distance between open lamps is about 164 ft., and between flame lamps 197 ft. to 394 ft. The lamps give a light of about 2,000 candle-power, and are fixed at a height of

about 30 ft. in streets from 33 ft. to 98 ft. in width.

One-half of the lamps are extinguished at midnight.

The total cost per annum per lamp, including interest on capital outlay, depreciation, and all other charges, is £17 13*s*.

Electric glow lamps are also used; there are 120 carbon filament lamps of 14 and 22 candle-power, taking about 50 and 75 watts respectively, and 111 metal filament lamps of 22 and 90 candle-power, taking 25 and 100 watts respectively.

Incandescent gas lighting is used generally in the streets and for ornamental lighting, and the lights are of the upright incandescent type, consuming about 4·4 cubic feet per hour, with an illuminating power of 72½ candles. The lamps are fixed about 10 ft. 6 in. above the roadway, and the cost per annum, including interest on capital expenditure, depreciation, and all other charges, is: up to midnight, £1 14*s*.; all night, £3 8*s*. 3*d*.

There are no public high-pressure gas lamps in Düsseldorf, but experiments with the low-pressure inverted incandescent lamps are being carried out.

Gas and electricity are made and supplied by the Municipality.

Dresden.

The total number of electric arc lamps in Dresden is 425, supplied by alternating current, the type of lamps used being: open (124), flame (301), the open lamps taking 500 and 375 watts, the flame lamps taking 350 watts. 238 lamps are fixed upon side posts, 187 being suspended across the centre of the streets, with side lowering gear.

The average distance between open lamps is about 148 ft., and flame lamps 180 ft.

The lamps are fixed at a height of about 26 ft. in streets having an average width of 65 ft.

The average cost per annum per lamp, including interest on capital outlay, depreciation, and all other charges, is about £26.

Electric glow lamps are largely used in the streets, and are fixed upon standards and brackets, and also centrally hung.

Seventy-two carbon filament lamps are of 14 and 22 candle-power, and take 55 and 87 watts respectively. Four hundred and thirty-seven metal filament lamps are of 22, 44, and 260 candle-power, and take 30, 60, and 330 watts respectively. The lamps are fixed about 100 ft. apart at a height of 16 ft., and cost £2 14*s*. per lamp per annum.

The side streets are lit by means of low-pressure incandescent gas in lanterns fixed upon brackets. The electric arc lamps are switched off at midnight, leaving incandescent gas lighting only.

There are 11,715 low-pressure incandescent gas lamps. The type of lamp used gives an illumination of 82 to 109 candles, and consumes about 5 cubic feet of gas per hour.

The lamps are fixed about 10 ft. 6 in. above the roadway at distances of 50ft. to 100ft. apart, the cost per annum per lamp being given as £3.

There are only fifteen inverted burner lamps.

High-pressure incandescent gas lamps are not at present installed in Dresden.

Gas and electricity are made and supplied by the Municipal authority.

Vienna.

The general arrangement for lighting is by means of electric lamps upon columns with incandescent gas lamps fixed upon brackets below, the electricity being switched off at midnight. The total number of electric arc lamps in Vienna is 1,155, of which 1,139 are supplied by direct current, 16 only being by alternating current.

There are no flame arc lamps used in Vienna for street lighting.

There are but five centrally hung electric lamps in this City. Up to the present there have been three cases in which arc lamps have fallen owing to breakage of the wire, but without causing injury to passers by.

The open lamps take about 660 watts, and are fixed upon standards at a distance of about 115 ft., at a height of 25 ft. to 40 ft. The average width of streets in Vienna is nearly 100 ft.

The cost per annum per lamp, including interest on capital outlay, depreciation, and all other charges, varies from £16 to £35, according to the hours of lighting.

There are 686 electric glow lamps in use for street lighting, and 148 for the three bridges over the Danube.

(1) The Reichsbrucke Bridge, with 100 carbon filament lamps of 25 candle-power.

(2) The Marienbrucke Bridge, with 28 metal filament lamps (Tantalum) at 50 candle-power.

(3) The Brigittabrucke Bridge, with 20 metal filament lamps (Tantalum) of 50 candle-power.

The electric glow lamps are fixed at a height of about 10 ft. At points where the traffic is heavy, as at street crossings, &c., two lateral arms (each with one carbon filament lamp of 25 candle-power) are fixed to the arc lamp columns. These glow lamps are not switched on until 12 o'clock at night, when the arc lamps are extinguished. The annual cost of those burning all night is £6 12*s.* 6*d.* per lamp, including interest and renewal of lamps, £3 11*s.* 9*d.* per lamp being the estimated cost of running the half-night carbon filament lamps.

Only nine high-pressure inverted gas lamps have been fixed for experimental purposes; these are of the "Graetzin" type, and the gas is supplied direct from a small compressing station placed in the cellar of an adjacent house at 53 in. pressure (water gauge).

The consumption of gas with two-burner lamps is 42 cubic feet per hour, the three-burner lamps consuming 84 cubic feet per hour each.

At present the lamps are only kept alight until 10 o'clock in the evening. They are fixed upon standards at distances of about 90 ft. to 105 ft. apart, at an average height of 23 ft.

No statistics can at present be obtained as to the annual cost of these lights. The cost of gas in Vienna is about 4*s.* per thousand cubic feet.

Low-pressure incandescent gas lighting is largely used both with the upright and inverted mantles. The shadowless so-called "Ritter" lanterns are generally used, consuming about 4 to 4¼ cubic feet of gas per hour, and giving a light of about 63 candles. The lampss are fixed about 11 ft. 6 in. above the roadway, measured from the burner, and are placed 60 ft. to 66 ft. apart, and are fixed upon standards upon the side of the footways.

The estimated cost per annum, including interest on capital expenditure, depreciation, and all other charges, is —for a single burner, evening £2 3*s.* 7*d.*; all night £2 12*s.* 3*d.*

The type of lamp principally used for the inverted incandescent gas light is the "Graetzin" burner, made by Enrich and Graetz, of Berlin, and contain two burners, with chimney for draught and ignition hole. The lamps consume about 7½ cubic feet per hour, and give an illumination of 234 candles. They are fixed at a height of about 14½ ft. from the roadway at distances of about 50 ft., the lamps being fixed upon standards upon the footways.

The side streets are lighted generally with incandescent gas (low pressure) fixed on wall brackets, and are placed at an average height of about 11½ ft. and about 82 ft. apart on the diagonal.

Gas and electricity are made and supplied by the Municipal authorities. There also exist two privately owned gas companies, and one private electric light company.

(*To be continued.*)

We regret to record the death, on Wednesday, July 28th, of Mr. C. A. Teuton, the Chairman of the Streets Committee of the City of London, whose name has recently become familiar to those interested in street lighting through the report of the Committee reproduced above.

"Mission" Types of Fixtures.

The accompanying illustrations, which are taken from a recent number of *Popular Electricity*, refer to a special type of electrical fixtures intended to harmonize with the so-called "Mission" style of furniture and decoration.

The two types of fixtures shown consist in a hanging ornamental cluster of five lamps and a massive oak fitting for an overhanging desk lamp, specially adapted, however, for the illumination of the music pages at a piano. An overhanging balanced lamp of this type seems a convenient way of dealing with the latter problem.

This style is said to be traditionally derived from the old Spanish régime in California, and to be influenced by the work and ideas of the old Franciscan monks in that part of the country. Furniture of this kind is of a somewhat austere and impressive character, more or less stern and simple lines prevailing, and the material being usually oak.

In such surroundings elaborate and shining metallic fixtures are felt to be inappropriate, and the electric fittings shown in the illustrations are intended to harmonize with the more sombre suggestions of the furniture. Massive woodwork is therefore employed, and coloured glass, which, while possibly inefficient as a means of distributing light, is said to have a very pleasing and æsthetic appearance when illuminated.

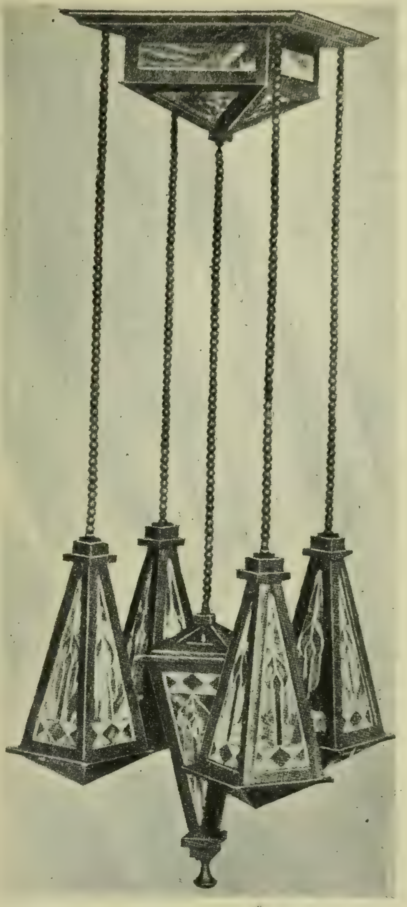


Fig. 1.—Hanging "Mission" Fitting.

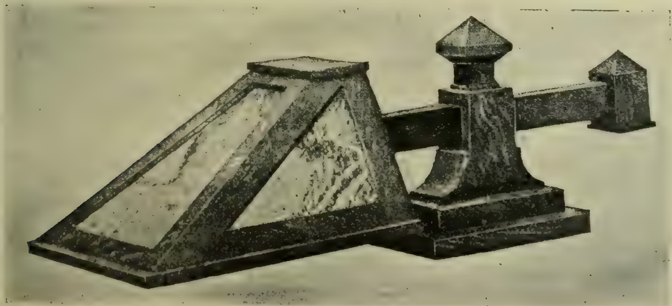


Fig. 2.

Type of massive desk-lamp for the illumination of the music page at the pianoforte.

Notes on Incandescent Gaslighting.

By Dr. C. R. Böhm.

(*Concluded from p.* 398.)

The third direction taken by efforts to produce satisfactory artificial silk mantles is indicated in those processes which involve the simple impregnation of artificial silk. The destructive influence of the superfluous nitric acid from the thorium nitrate upon artificial silk is well known, and must be carefully guarded against. While some inventors recommend the use of basic solutions of the incandescing material, others prefer colloidal solutions arising through the production of thorium hydroxide from a solution of the nitrate. As far as basic salts, which are produced by the neutralization of the excess of nitric acid, are concerned, it may be pointed out that this idea finds expression in Patent No. 107,046 of Feb. 25th, 1898, and was therein practically applied, for it is stated: "By this means nitrate can be obtained which (dried at a temperature of 100°) contains up to 70 per cent of oxide instead of only 48 to 49 per cent, as in the case of nitrate of the ordinary variety."

Artificial silk, as used in practice to-day, is not tubular in structure, but solid, and therefore must be subjected to the action of the impregnating fluid for a longer period than cotton or Ramie thread. Schlumberger and Sinibaldi (Belg. Pat. 106,592, Oct. 16th, 1892; see also Hicks, Am. Patent 641,698 of Jan. 23rd, 1900) had, previous to Plaissetty, shown the possibility of impregnating artificial silk with incandescing material instead of incorporating the latter in the collodion paste before squirting. The web ought to remain in the impregnating fluid at least four to five hours, and it is even preferable to leave it soaking overnight. The artificial silk is capable under these conditions of taking up from a solution containing 50 per cent of active material about two and a half times its own weight. Ten grams of artificial silk suffice for the manufacture of six mantles, which are 23 to 25 cm. long, and, after burning, shrink to about 11·5 cms. in length. The ashed skeleton weighs about one gram.

A distinction must, however, be drawn between the so-called "Collodion silk" (Chardonnet) and the "Copper-oxide-ammonium" silk (Elberfelder). The former can be impregnated with greater ease than the latter, but is less durable in the wet condition. When collodion silk is concerned, the thread must be denitrated with ammonium sulphide previous to being woven, *i.e.*, the explosive nitro-groups in the material must be removed in order that the burning away of the mantle may subsequently proceed at a slow rate. In the "undenitrated" state this silk will not take up any impregnating material, and therefore Boulier (G. P. 161, 262, Sept. 3rd, 1902) proposed first to subject it to treatment with formic, acetic, or nitric acid, which is supposed to increase its capacity in this respect.

This process, however, seems to me to be superfluous, for the impregnation of the silk does not take place previous to the denitration, but always after this and the process of weaving have been completed. As a result of the colloidal nature of the silk almost any quantity of the fluid can be taken up, though it is true that the process of absorption does not take place as rapidly as in the case of natural vegetable cotton, or Ramie thread. As a rule a 50 per cent solution is utilized, the excess after impregnation being removed by centrifugal means. At present it has not been found possible to prepare an impregnated mantle by ashing and subsequently forming and hardening in the high pressure gas flame. For the mantle, as soon as the incandescing salts in its fabric are

converted by the heat into oxide, shrinks together and does not alter uniformly as do the ordinary cotton and Ramie thread mantles.

It has therefore been found necessary to convert the incandescing nitrate in the mantle into hydroxides or super-hydroxides by the agency of hydrogen peroxide, &c. As this so called "fixing" is a more or less elaborate process efforts have also been made to attain the same result by simple impregnation. It is well known that Auer was compelled to avoid the use of thorium nitrate in the liquid, since his variety of this substance was yet more markedly acid than the substance in use to-day, and thus gave rise to the free nitric acid, which, as we have seen, exerts a destructive influence upon cotton thread and must therefore be neutralized by means of ammonium; that this effect was fully known to Auer is proved by the contents of his famous patent. Since nitric acid mainly exercises its malign influence upon organic thread in the presence of water, and since mantles impregnated with acid thorium nitrate are very hydroscopic, these mantles were even more easily destroyed than the dry ones.

Mantles which are not burned off (Flachwaren) play a great part in the mantle industry, for most gas concerns purchase their mantles in this condition and burn them off themselves. For the dealer in this direction mantles of this kind offer the advantage of being subject to a smaller tax than the burned off variety. However, it is advisable not to keep the mantles too long in this state, for in such instances, especially in the case of oversea traffic, when mantles are packed away for four or six weeks, they might prove on arrival to be completely eaten away and useless to the purchaser. On this account makers have not infrequently availed themselves of the method recommended by Auer, of treating the mantle with ammonia vapour in order to remove the free acid (see Böhm, Das Gasglühlicht, 1905, p. 73).

The action of free acid upon the denitrated artificial silk has only been studied recently, since it became customary to impregnate instead of to incorporate the incandescent material in the collodion paste previous to squirting. Hitherto it had been the general opinion that a serviceable artificial silk mantle was only to be obtained by subjecting the dry impregnated fabric to a suitable fixing bath, such as served to convert the nitrate into colloidal hydroxides or super-hydroxides, in the form of a compound insoluble in water. As we have seen this can be accomplished by means of the ammonia or the hydrogen peroxide process. In the latter case either the fluid or the hydrogen peroxide bath must have about 5 per cent of cerium added, as nearly all the cerium in the fabric would otherwise be extracted. This inconvenience is avoided in the latest development of the British Patent 2240/08 by adding to the hydrogen peroxide bath substances such as cause the thorium to be converted into a condition insoluble in water simultaneously with the cerium. If, however, this modification is not employed the simple process consists essentially of :—

1. Impregnating the artificial silk with thorium nitrate.
2. Conversion of the nitrate into a condition insoluble in water.
3. Subsequent impregnation with cerium; this process was introduced at a time when the original method seemed possibly covered by the Auer patents.

It will, however, be readily understood that if one proceeds on these lines a product will eventually be obtained which is anything but uniformly luminous. It would indeed prove almost as irregular in this respect as that obtained in the German Patent 188427 by the aid of their simple hydrogen peroxide process alone.

If the fabric were first dipped into an ammonia solution and afterwards into the impregnating solution, it would be impossible to secure a serviceable mantle. For very little of the easily volatile ammonia would remain in the fabric after the first minute, and the hydroxide formed from the thorium nitrate would be rapidly re-dissolved.

The manufacture of artificial silk mantles, therefore, will be seen to be

attended with a not inconsiderable number of difficulties, just as was previously the case for the Ramie mantle. Yet these difficulties are being rapidly overcome, and there is no doubt that this improvement will be eventually of very great benefit to the mantle industry.

II.—THE "BUISSON-HELLA" MANTLE.

The types of mantles previously described consisted of an ashed skeleton composed of very fine fibres. This has been proved by experience to be necessary, for otherwise too much heat would be absorbed and relatively little light radiated. It is true that the solidity of a mantle may be to some extent increased if a stronger impregnating solution is employed; however, the gain in durability thus secured is so slight as to be of but little practical value. The luminous emissivity of such mantles is abnormally low. Attempts have been made to utilize various non-combustible materials, fine wires, asbestos thread, &c., with the object of solving this problem of increasing the strength of mantles, but such investigations have invariably led to a negative result, as on the above grounds one would naturally expect.

Experiments in this direction were carried out by Fahnehjelm (G. P. 29498, Nov. 18th, 1883), who arranged rods of oxide in the form of a comb, by de Mare (see Böhm, Das Gasglühlicht, 1905, pp. 85–86), and by Michaux and Delasson, in France.

The Buisson-Hella mantle utilizing rods of oxide is based upon similar principles, but, as explained above, there seems at present to be scientific difficulties which are unfavourable to the achieving of a high efficiency from mantles of this class.

Nomenclature of Arc-Lamps.

THE "Lichtnormalien-Kommission" of the Verband Deutscher Elektrotechniker recently issued a note regarding the terms to be applied to describe different types of arc-lamps. At present it is pointed out that most of these terms are not very clearly defined.

The regulations apply to :—

1. The nature of the exclusion of air from the carbons.
2. The positions of the carbons.
3. The variety of carbons.
4. The variety of current used.

They are not intended to apply to mercury vapour lamps, nor to special apparatus such as projection arc-lamps, &c.

They define an "enclosed" arc as one in which *any* effort is made to exclude the air and to burn the arc in an atmosphere impoverished in oxygen. In the same way the position of carbons falls under either the expressions "situated above" or "situated side by side." A distinction must also be drawn between "pure" and "flame" (*effekt*) carbons. The latter term, it is true, is not always properly descriptive, but has come to be used for all kinds of chemically treated carbons, and is in very general use.

In describing a lamp, therefore, the following formula should be used :—

$$\left.\begin{array}{c}\text{Open}\\ \text{or}\\ \text{Enclosed}\end{array}\right\}\text{Arc-lamp with carbons situated}\left\{\begin{array}{c}\text{one above the other}\\ \text{or}\\ \text{side by side}\end{array}\right.\text{, using}$$

$$\left.\begin{array}{c}\text{Pure}\\ \text{or}\\ \text{Flame}\end{array}\right\}\text{carbons, and}\left\{\begin{array}{c}\text{Direct}\\ \text{or}\\ \text{Alternating}\end{array}\right.\text{current.}$$

Decorative Electric Lighting.

(Elektrische Lichteffekte nebst einem Anhange; Die elektrische Notbeleuchtung in Theatren und Festräumen, by Prof. W. Biscan, published by Carl Scholtze, Leipsic.)

THE development of new methods of electric lighting has led to possibilities in the use of light for decorative purposes, and for the production of special spectacular effects, such as were certainly out of the ken of our forefathers; it is probable that the improvements of the future will lead us to make use ot light in this way to an even greater extent. In the United States the display of lighting for decorative purposes in public lighting on festive occasions is, perhaps, exceptionally elaborate, and at the present day the method of lighting forms a very important feature in the appeal to the eye in many theatres and entertainments. Naturally, therefore, the publication of such a work as that of Prof. Biscan, which deals exclusively with light for decorative and spectacular purposes, is of particular interest at the present moment. In the preface the author states that he has sought to deal with problems in a practical manner and to give the results of his own experience, and the book is of a very readable character.

In the first chapter the author considers the available electrical sources of light which can be effectively used for scenic display. He does not deal with gas lighting in this work, although he mentions that the flickering, quivering quality of a naked gas flame, objectionable as it would doubtless be considered were the light applied for reading, &c., is often an actual advantage from the spectacular standpoint, since it gives an impression of life which the steady glow-lamp does not do. The use of glow-lamps receives most attention in this chapter, and various fantastic forms of globes and reflectors are described. Tubular lamps are also coming into use for lettering and the imitation of certain kinds of plants, &c.

It is satisfactory to observe that early in the third chapter the author emphasizes very clearly the necessity of screening the eye from the direct rays of intense sources of light—a principle which is not always observed by those who attempt decorative lighting. This chapter also contains an up-to-date review of the chief electric illuminants available, such as flame arcs of various kinds, the Küch Mercury Vapour lamp, &c. We should, however, like to have seen some reference to the Moore tube, which though, perhaps, not yet very well known outside the United States, might be supposed to be of useful application for some forms of decorative lighting.

The second chapter is devoted to shop window lighting, which the author very properly regards as in the same category as other forms of lighting designed to appeal to the eye. Even when the merchant does not care to bestow thought on the artistic side of the subject, however, and is content with merely producing a sufficiently high intensity of illumination to enable his goods to be seen, the important rule regarding the screening of direct rays from the eyes of the passers-by must be insisted upon. The accumulation of bright sources of light, in order to attract notice, the author declares, often fails in its purpose simply because the passer-by involuntarily directs his eyes elsewhere after glancing at the glaring light. In this connexion it is interesting to observe that the recommendations of the author on this point are in very close accord with that frequently made in these columns.

"It should not," he says, "even be considered absurd to recommend an enforcement of regulations by the police authorities, forbidding the use of extremely powerful lights near the ground level; such sources unquestionably offend the eye, and this is perhaps the most precious possession

which it is given to each of us to possess in these modern times."

Prof. Biscan then proceeds to comment upon the colour of the light yielded by different illuminants. This is naturally a very important matter for those interested in shop lighting. Colour is not, like shape or weight, an inherent quality of an object independent of the illumination; where there is no light there is no colour, and the quality of colour which any object appears to possess is dependent upon the nature of the light falling upon it. The most peculiar quality of light which we are called upon to deal with in practice is probably that yielded by the mercury vapour lamp, but some yellow flame-arcs also give rise to very peculiar effects. As an illustration of the colour-distortion that may occur in this way, Prof. Biscan has reproduced four multi-coloured diagrams, in which the appearance of a series of different tints, as seen by daylight and by a yellow flame arc, mercury vapour lamp, quartz tube, and incandescent mantle are pictured. A second illustration serves to compare the appearance of a tablecloth, on which are placed various flowers and fruits, as illuminated by daylight and by the light of the mercury vapour lamp. Naturally the quality of illumination referred to must depend upon the kind of goods displayed. Choice varieties of china, silk, and linen goods, and any objects which contain delicate shades of colour, ought to be illuminated by a source which resembles daylight as closely as possible.

The arrangement of the sources in a shop window is of great importance. In many cases the use of an arc lamp with inclined carbons, placed above a ground glass screen over the goods in the window, can be used with advantage. A large number of small sources let into the ceiling are also satisfactory when it is desired to produce a very uniform illumination, when, for instance, a large number of small objects are to be illuminated, and it is desired to avoid multiplication of shadows. The author instances the case of a jeweller's shop, where in judging the quality of diamonds, &c., it is very essential that light should reach each individual gem from a number of different directions. When examining a stone in daylight we involuntarily turn it this way and that so as to reflect the light from different facets. In the same way in certain jewellers' shops in the United States artificial illumination is utilized even during the daytime, a revolving light being employed to produce an effect analogous to that secured by moving the stone by hand. It is desirable, therefore, that a number of sources in different parts of the shops should be employed, and it is also sometimes an advantage to contrive a fluctuation of the light, such as would be caused by alternating extinguishing lights in different parts of the window, so as to produce the impression of sparkle.

Lastly, the author remarks that the plan of surrounding lamps in shop windows with coloured glass is in general not to be recommended, because a great deal of light is absorbed thereby, and the introduction of a marked colour in this way is rarely satisfactory in the interests of the goods themselves.

When dealing in chapter 3 with the lighting of interiors, the author insists again upon the importance of placing bright lights high up out of the range of view. From a decorative point of view additional local lights may be wanted, but these should be carefully screened, otherwise they will fail in their artistic intention. Special provision may be made for festive occasions, such as festoons of lamps, &c. Prof. Biscan points out, however, that these should not be made up from lamps with clear bulbs, but frosted or obscured lamps should always be used, and it is also a good plan to distribute these among greenery and floral decorations; there is also room for the choice of lamps of suitable colour contrast, but the tints have to be carefully chosen. An interesting special case of decorative lighting was that devised by the author at a winter carnival, when the lamps were enclosed in diffusing cones of ice.

Dealing with the lighting of public gardens, &c., the author again refers to the value, from a decorative point of view, of lamps distributed amid

green foliage. In shady avenues, for instance, lights distributed among the trees may give rise to a pleasing decorative effect, even though a considerable degree of ground illumination be lost thereby. In the same way lamps may be distributed round the edge of flower beds so as to illuminate the flowers and leaves of the plants; it is, however, advisable to avoid the exhibition of a naked filament, which may tend to dazzle the eye rather than to bring out the quality of the flowers.

In the fifth and sixth chapters the author deals mainly with decorative sign lighting, &c. He describes various methods by which strings of lamps can be cheaply and rapidly installed, and subsequently explains a number of devices by which special sign effects may be secured.

This section of the book will be found of special interest. Special emphasis is laid upon the artistic possibilities of such signs when the brilliancy and colour of the sign and its background are suitably selected. Ordinary coloured glow lamps are somewhat expensive, and are also open to the objection that only a few crude tints can usually be obtained. More artistic effects are to be produced by staining lamps in solutions of aniline dyes in collodion and ether. Such lamps, however, are soon affected by storm and rain, which are apt to wash off the colouring matter.

Of special interest are the methods by which the periodical extinguishing of light of glow lamps is caused to produce the impression of motion, such as rotating wheels, writhing snakes, &c. Combined with periodical colour-changes very striking patterns can be thus produced. Successively lighted spirals of glow lamps constitute a well-known device, and the same method was applied by the author to represent shooting stars in an operetta entitled 'The Three Wishes.' Another device consists of the rotation of a series of lamps so as to produce luminous concentric circles; it must be noticed that in this case the brightness of the lamps from the outer to the inner circle must be considerably graduated; otherwise the outermost circles would appear to be of lower brilliancy than those nearer the centre. Lights may also be arranged to travel on cycloids and other curves.

The seventh chapter deals mainly with projection lamps of various kinds and their application in theatres. In such cases special precautions must be taken to obtain as steady a light as possible. A form of projector lamp which finds an extended use on the stage utilizes a parabolic mirror with vertical carbons, and serves to direct a beam of light in any desired direction, and to follow the motions of the actor, &c., so that, as he moves about the stage, he is always more brightly illuminated than the surroundings. Incidentally some description is given of the ingenious methods by which the illusions of cinematograph entertainments are produced.

In chapter 8 the author deals with the art of illuminating fountains and cascades, and studies the conditions under which the reflection of light from water can be arranged to give rise to artistic effects. In some cases it is essential to break the water up into fine globules because the reflecting power of water in these conditions is improved. An ingenious device, utilizing the principle of total internal reflection, is also made use of in order to illuminate a stream of water issuing from an orifice and following a parabolic course. If the light is concentrated on the jet as it leaves the tank the rays, once enclosed in the stream, remain inside and cause it to appear highly luminous. This effect is intensified by throwing into the water some powdered chalk or fluorescein, &c.

Although the illumination of fountains by coloured light has been hitherto used mainly for stage effects, &c., the author states that a similar arrangement is being erected to illuminate one of the public fountains in Vienna. This interesting application of spectacular lighting to ordinary conditions may be compared with the decision recently taken in the United States to illuminate the Niagara Falls by means of coloured searchlights.

The ninth chapter is devoted to the subject of theatre lighting. This is in itself a fairly wide subject. The illu-

mination needed in a theatre may be divided into (1) the intended or the auditorium, (2) the illumination of the stage, and (3) the illumination of the orchestra. In designing the general lighting of theatres artistic considerations are naturally of paramount importance, and at the same time it is, of course, particularly essential to arrange the lights so as to have a soft and pleasing effect, and to avoid, as far as possible, any degree of dazzling. In some theatres, it may be remarked, the excellent plan has even been adopted of dimming the lights gradually when the curtain goes up, so that the audience are not inconvenienced by an abrupt change in the general illumination. The author deals in some detail with the various fixtures for the general illumination of the stage, and for the production of special effects. Some of these have already been described in *The Illuminating Engineer* (August, 1908, p. 645).

Some of the methods of producing stage-illusions are very interesting. The mercury vapour lamp is found to be particularly suitable for producing moonlight and, in conjunction with glow lamps, simulating the appearance of evening. Lightning is imitated by the rapid switching on and off of arc lamps, a close resemblance being sometimes secured by the addition of potassium salts to the carbons. Again there are several well-known instances in operatic work, such as the duel between Faust and Valentine and the forging of the sword of Siegfried on the anvil, where the clashing of steel is made to give rise to obvious sparks. This is very conveniently secured by arranging that the contact of swords or of steel on the anvil makes and breaks an electrical circuit; in order to intensify the effect iron powder is sometimes scattered over the anvil in such cases. Molten metal is usually imitated by the flowing water illuminated with strong red lights. Jack o' lanterns, glow-worms, &c., are imitated by tiny electric lamps and occasionally by small Giessler tubes.

A special section is devoted by the author to the question of the varieties of electrical installations best adapted for theatre lighting, and of the methods of providing security against fire. In passing it may be noticed that it is very desirable to have several independent lighting circuits in the orchestra, so that in the event of a breakdown of one of them the music need not be interrupted. It is also obligatory for an independent emergency system of general lighting to be adopted in theatres. Portable oil lamps are sometimes employed. A special method which finds favour with the author is the provision of an entirely separate electrical installation fed by accumulators in a fireproof basement, the mains being taken vertically upwards in steel tubes immersed in plaster. It is stated that so long as the building is inhabitable at all the mains will remain uninjured by the fire, if this method is properly carried out and due precautions taken.

It will be seen, therefore, that in this work Prof. Biscan covers a wide ground. A work on this special subject was certainly needed; indeed many of the points here dealt with in a summary manner might well form the subject of yet more specialized treatment. Meantime the author is to be congratulated on a readable book on this interesting subject, which contains much sound advice and useful information.

Lists of Books and Papers on Gas.

The Journal für Gasbeleuchtung for May 8th contains an interesting list of books and periodicals dealing with gas production and gaslighting issued in Europe and the United States; the list contains many items that might be of considerable interest to illuminating engineers.

Co-operation between Gas and Electricity Departments.

We have been much struck lately by the growing frequency of municipal committee suggestions that the time has come when the gas and electricity departments should work harmoniously together and cease all competition.—*The Electrical Times.*

Illumination and Imagination.

By an Engineering Correspondent.

Facility in imagination should be the aim of the ideal illuminating engineer. If the conception of "images" be the ultimate satisfaction of scientific and artistic intellect then the provision of facilities for such conception is of highest importance in human environment. Chief among the essentials for *correct* or *harmonious* perception we must rank *eye-power*, and therefore harmonious illumination, for the ability to conceive correct or harmonious images depends on accuracy or harmony in perception, and the latter depends on harmony in *presentation* or illuminating effect.

Although the adept observer regards form as an immediate percept, a little practical analysis of eye-impressions will prove that "form" is an image, a "concept" or mental idea based upon the percepts of light and shade. With familiarity the formation of the ideas of shape become instant with the percepts of contrasts of illumination, and through that familiarity are generally confused with those percepts.

One object of the illuminating expert is therefore the adjustment of illuminating effect to the relation between percipient and the thing perceived. He must attack his problem in a dual capacity, as regards the result of his work on the "thing perceiving" and as regards the effect on the opportunity for the "thing to be perceived" In illumination, of all sciences, this duality is essential to any degree of success.

The case of an audience at an entertainment will illustrate this quality. A large number of people put aside their own personality on the way to the hall, their minds are limited to the expectation of the performance. No perfection or grotesqueness of the general illumination will attract any conscious or unconscious notice, as long as the platform is well lit and they can "see well." Certain others will go in search of something to divert their thoughts. They go preoccupied; their minds are not concentrated on the definite purpose of being entertained. Thus an erratic arc lamp or absence of harmony in the general illumination will have a distressing effect.

The appearance, however, of an exceptionally fine performer will hold their attention, and the previous discomfort will vanish.

The first set of people are already self-hypnotized against response to other stimuli than they expect, whereas the second class reach that stage only when the powerful stimulus arrests the majority of responses to outside influences.

It is probable that many people keep away from even high-class variety entertainments, not from the moral distaste to which they ascribe their action, but through an unconscious artistic repulsion due to the glaring, inharmonious lighting both of the exterior and interior of the auditorium.

It may be urged that the forcible illumination attracts the crowd, even if it annoys the refined. As I have shown, the crowd is attracted by its own expectation of enjoyment. The result of "vulgar" illumination is therefore to keep away the more artistic patrons from many refined entertainments.

Of course the lighting arrangements are not the only ones which might be altered in many music halls with economy as well as increase in comfort.

We are all inclined to put much virtue in "candle-power." We have not yet recovered from the sudden increase in comfort through the introduction of high-power lamps in place of the feeble burners of a quarter of a century ago. We act as if we supposed

that a forty candle effect on the thing to be perceived had double the value in the visual power of the observer of a twenty candle illumination.

In practice, however, the threshold of consciousness (Weber's Law) widens with increasing stimuli, and the increase in appreciation of stimulus is not proportionate to the increase in intensity, but to the ratio between the increase and the previous stimulus until any given stimulus is equal to the power of response, and any increase is impossible of appreciation.

A white surface may be comfortably visible at a given distance. Any increase in intensity of the light thrown on the surface will render it visible at a greater distance, but if the former distance be that at which observations may be most comfortably made then such increase in intensity tends to reduce the ability of the observer to form correct mental " images " through over - stimulating certain perceptive faculties to the inhibition of others.

In the case of illumination the limit of difference-perception is comparatively low. Further, a great deal of the response to illuminations, greater than diffused daylight, is by other than the sense of sight, and simply causes fatigue, strain, or intense discomfort, according to degree.

The formation of images depends then on the condition of the illumination of the object, not in terms of absolute standards of ergo or of " units " of light, but in terms of *eye-power*.

The eye does not see outlines except deliberately. The tone-contrasts are perceived, and by familiarity of objects showing similar contrasts and analogy with other senses in relation to such objects a mental picture of the thing seen is " imagined." Such " imagination " is modified afterwards in terms of impressions from different aspects, giving more efficient data for imagining.

The bearing of this relation between " image " and object on the art of illumination is in the direction of colour and tone development, rather than " definition " of outline and shape. Intense uniformity of monochromatic light is to be deprecated, both because of the preceding argument and also on the score of eye fatigue.

Our faculties of perception and of forming images are developed in consequence of the age-long periods of natural illumination in which man lived. With the advent of artificial lighting as a universal part of our environment one of two things must happen : either our eyes and brains must modify, with a consequent waste of individuals, so as to utilize the artificial illuminant to best advantage, or the new art must develope so as to require a minimum of modification in the already highly specialized organism.

The Illumination of Baseball Grounds by Night.

It will be remembered that in a recent number of this journal we referred to the possibility of artificially illuminating athletic grounds in order to enable matches to be played by night (*Illum. Eng.*, Lond., May, 1909, p. 318).

It may now be noted that in the August number of *Popular Mechanics* a reference is made to the night-lighting of a baseball ground in Cincinnati in the United States, which was accomplished by a series of powerful arc lights placed round the ground on towers 100 ft. high. In this way a strong light was directed on the ground itself, but at this height the lights are stated not to exercise any unduly dazzling effect. The equipment consists of fourteen powerful arc-lamps fed by a 250 h.-p. dynamo installed in the ground. Baseball and athletic sports of every kind are now frequently carried out by night on this ground. The adjoining illustration is a photograph taken at 10 P.M., and showing the ground illuminated for play.

A recent number of the *Electrical World* also refers to a baseball game played by the aid of electric light at Grand Rapids, Mich., U.S.A. The illumination was provided by 40 lamps, 28 of which were flame arcs hung high above the field, and there were also searchlights to produce special local illumination.

It seems to be felt, however, that the problems of illuminating fields successfully for play is not an easy one. It is a difficulty, for instance, to arrange the lights so that the player can catch a high ball without dazzle, or indeed follow the track of any ball which is hit high in the air. Under the circumstances it is not surprising to learn that in this case the play was not quite of the highest standard. There is, however, reason to hope that after careful study more successful results may be obtained in the future.

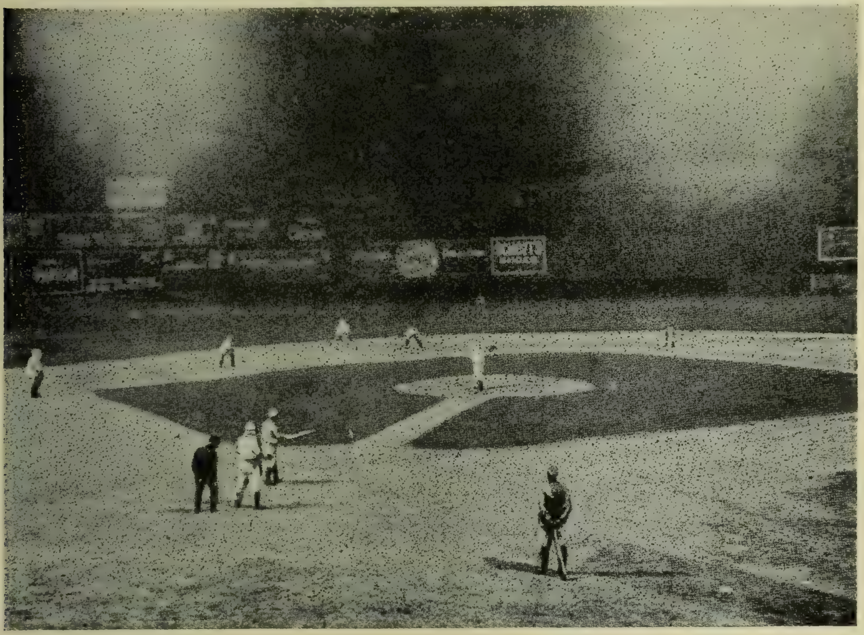


FIG. 1.—Illumination of Baseball Ground in Cincinnati, U.S.A.

Maxims for the Illuminating Engineer.

THERE *is* use in hoping. The man without hope in his heart is standing in the way of his own advancement—in the path of his own progress. Back of the right kind of hope there must be *faith*—an unswerving, unchangeable, unshakable faith—the kind that "moves mountains." Hope alone will not suffice. There must be belief. There must be the firm conviction that the object of our hope is attainable. There must be the do-or-die determination that weaves realities from the material of our dreams.—*Light*, July, 1909.

Give me the man who can hold on when others let go; who pushes ahead when others turn back; who stiffens up when others weaken; who advances when others retreat; who knows no such word as "can't" or "give up"; and I will show you a man who will win in the end, no matter what opposes him, no matter what obstacles confront him.—*Light*, July, 1909.

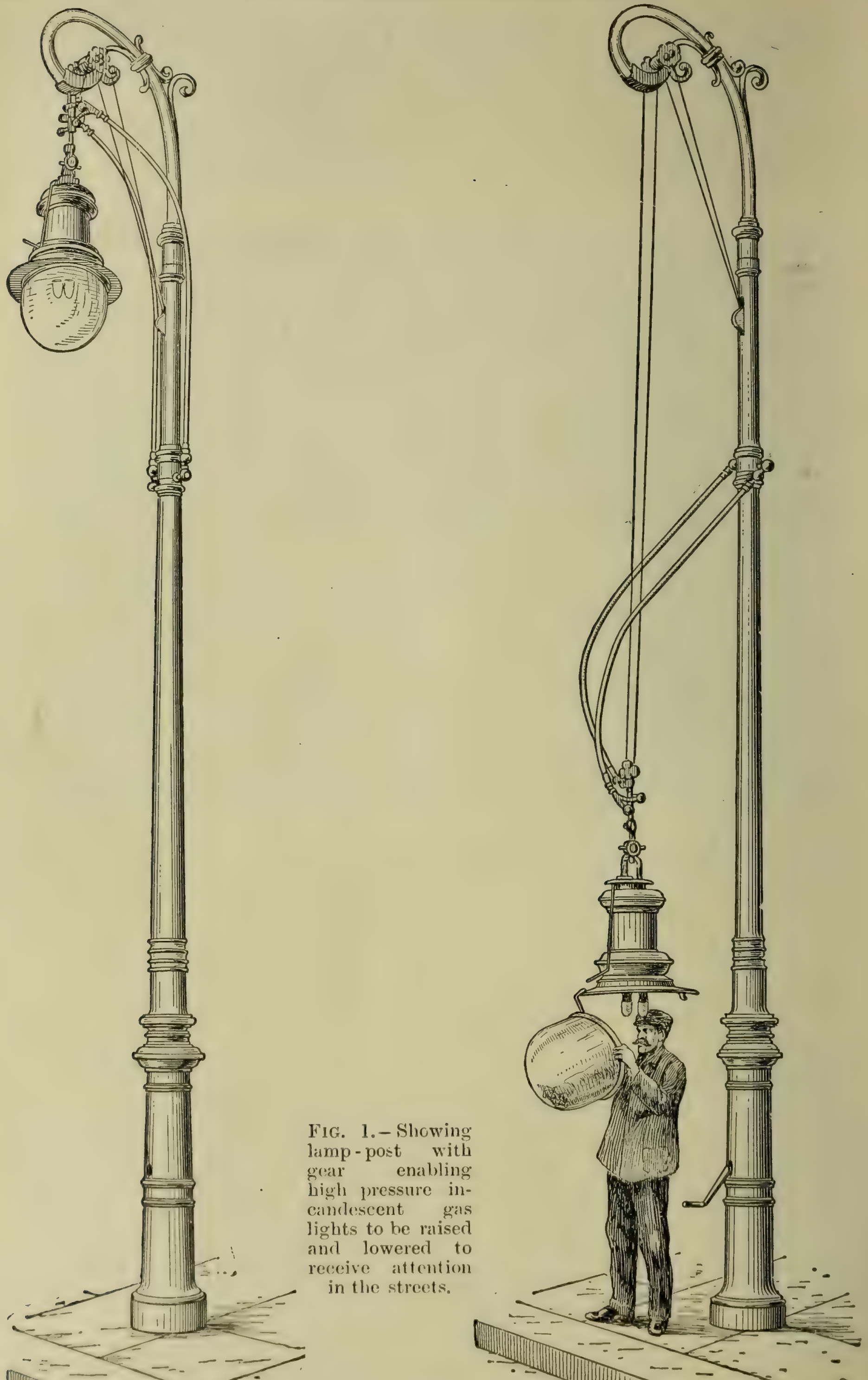


FIG. 1.—Showing lamp-post with gear enabling high pressure incandescent gas lights to be raised and lowered to receive attention in the streets.

(For the use of this illustration, which occurs in the Third Cantor Lecture on Illumination by Mr. L. Gaster now published in the Journal of the Society of Arts, we are indebted to the courtesy of the Society.)

TRADE NOTES.

[At the request of many of our readers we are extending the space devoted to Trade Notes, and are open to receive for publication particulars of new developments in lamps, fixtures, and all kinds of apparatus connected with illumination.

The contents of these pages, in which is included information supplied by the makers, will, it is hoped, serve as a guide to recent commercial developments, and we welcome the receipt of all *bona fide* information relating thereto.]

Some Recent Advances in Incandescent Gaslighting.

Messrs. Ehrich & Graetz (Berlin) kindly send us some particulars of recent developments in incandescent gas lighting made by the firm, which should be interesting to our readers at the present moment when the lighting of streets by this system is attracting so much attention. By the courtesy of the makers some of these most recent developments were shown in action to the editor of this journal during his visit to Berlin last month.

Messrs. Ehrich & Graetz, however, have not confined their attention only to improving high candle-power lamps, but also inform us that they have recently introduced a small burner (No. 37), which, with a consumption of 20 litres (about 1·3 cubic feet) of gas per hour, yields an intensity of 30 H.K. This is about the intensity derived from a good petroleum lamp, but is claimed to be produced at a much lower cost; this burner will, it is thought, be very serviceable in cases where a relatively small but efficient light is wanted. Burners are now therefore available yielding intensities of 100–120, 50 and 30 H.K. respectively.

In addition attention has been paid to the automatic control of admission of gas to inverted burners, particularly as regards regulation of pressure. A newly introduced device of this type is stated to enable the gas to enter the burner with a relatively small loss of pressure at the nozzle. The gas passes through an adjustable orifice, which in its normal condition is regulated to permit a pressure of about 35 mm. If the pressure tends to rise, however, two flaps close together so as to diminish the access of gas and automatically maintain it constant at its former value. This device, it is thought, will be of particular service on networks where the pressure is very variable, and this variation affects mantles unfavourably.

Attention has also been paid to the design of lanterns and burners for outdoor illumination. One direction in which progress has been made in recent years by several firms has been the substitution of two or four mantles, each of which can be extinguished separately, instead of one single very long mantle. This method has several advantages. To begin with, a small mantle is distinctly less fragile than a longer one, and may also possess a higher efficiency as an illuminant. In addition, if one such mantle is broken the light from the lamp is not entirely extinguished. On the other hand, when only a single mantle is used a breakage puts the lamp entirely out of action.

Another advantage of the multiple mantle system is that it is possible to extinguish all save one late at night, and thus to accomplish a saving of gas and yet not to leave the streets in complete darkness. A point which is also worth notice is that when a cluster of four mantles are replaced individually at certain intervals, the candle-power of the lamps as a whole can be maintained at a much more constant value, since when one mantle has reached a stage when it requires replacing, and therefore yields a diminished light, some of the other mantles will probably still be at their best. On the other hand, when only a single mantle is used it is evident that just previous to its being replaced by a new one the candle-power of the lamp must have reduced considerably.

Another development introduced by Messrs. Ehrich & Graetz has been the introduction of small compressor plants suitable for the supply of six Grätzin high pressure lamps credited with a total candle-power of 9,000 H.K. This small plant is stated only to require about 80–100 cubic metres of space and weighs about 60 kilograms. The plant is usually worked by small electric motors, but where electricity is not available a small gas engine may be used.

Perhaps, however, the most interesting development has been the introduction of arrangements enabling incandescent gas lamps to be raised and lowered in the streets, and even to be slung on wires across the street, in the same manner as has recently been done in this country in the case of electric arc lamps. A view of a lamp-post enabling lamps to be lowered in this way will be seen in Fig. 1. In this case, it will be noted, two jointed pipes are attached to the

lamp, but only one of these is utilized for the actual supply of gas; both, however, serve to guide the lamp up and down. It will be seen that the lamp is raised and lowered by a double cord from below, but when hanging at rest, as shown in the post on the left, the lamp does not depend on the cord for its support. Special provision is also made to reduce the vibration due to winds, &c., to a minimum.

The illustration shown in Fig. 2 refers to the method of suspending high pressure gas lamps in the centre of a road. The lamps will be observed to be hung on wires just as electric arc lamps frequently are. In some quarters flexible tubes have been used for this purpose, but it is said that a joint is now found more satisfactory. In this apparatus the lamp is first drawn to the side of the road by means of the cord, and is then lowered to receive attention. This device has been utilized in the town of Stuttgart, in Germany; a general view of some high pressure gas lamps slung on wires spanning a street of this town will be seen in Fig. 3. As this method has been recently recommended by the Deputation of the Streets Committee of the City of London, who recently visited the Continent, the above illustrations should be of special interest to our readers.

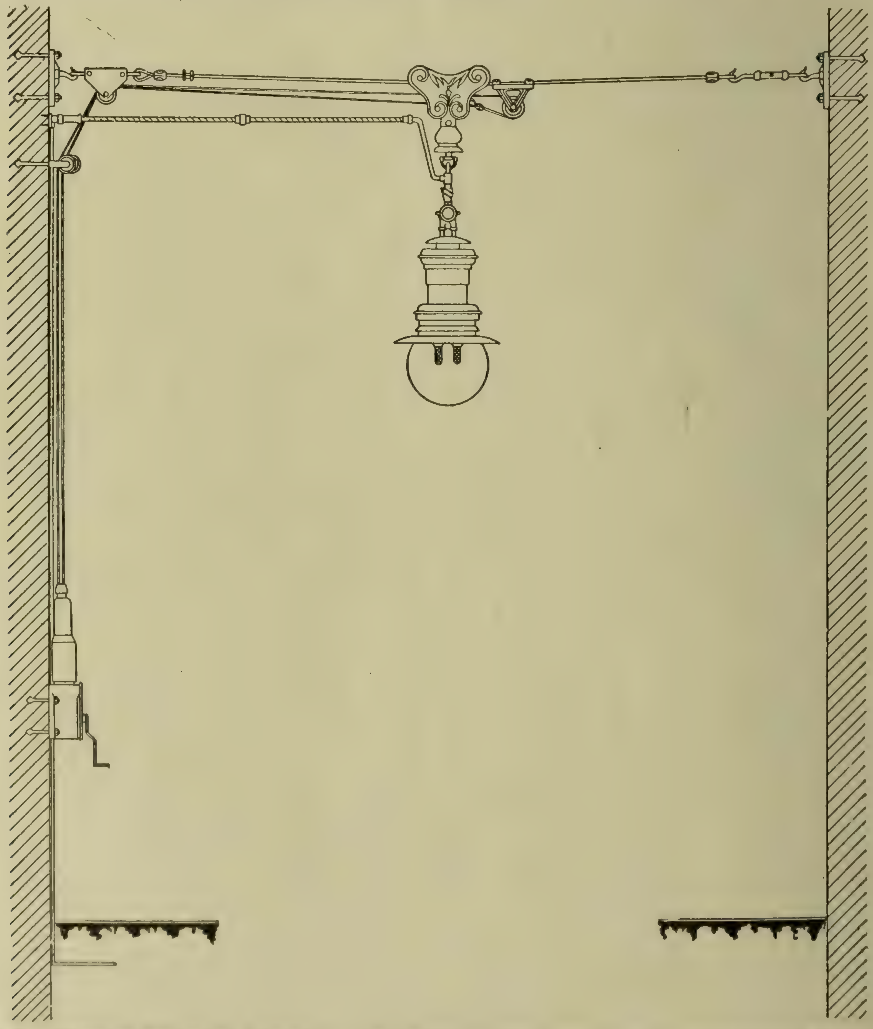


FIG. 2.—Showing method of suspending high pressure incandescent gas lamps on wires spanning street. When the lamp is to receive attention it is drawn to the side of the road and lowered by the winch.

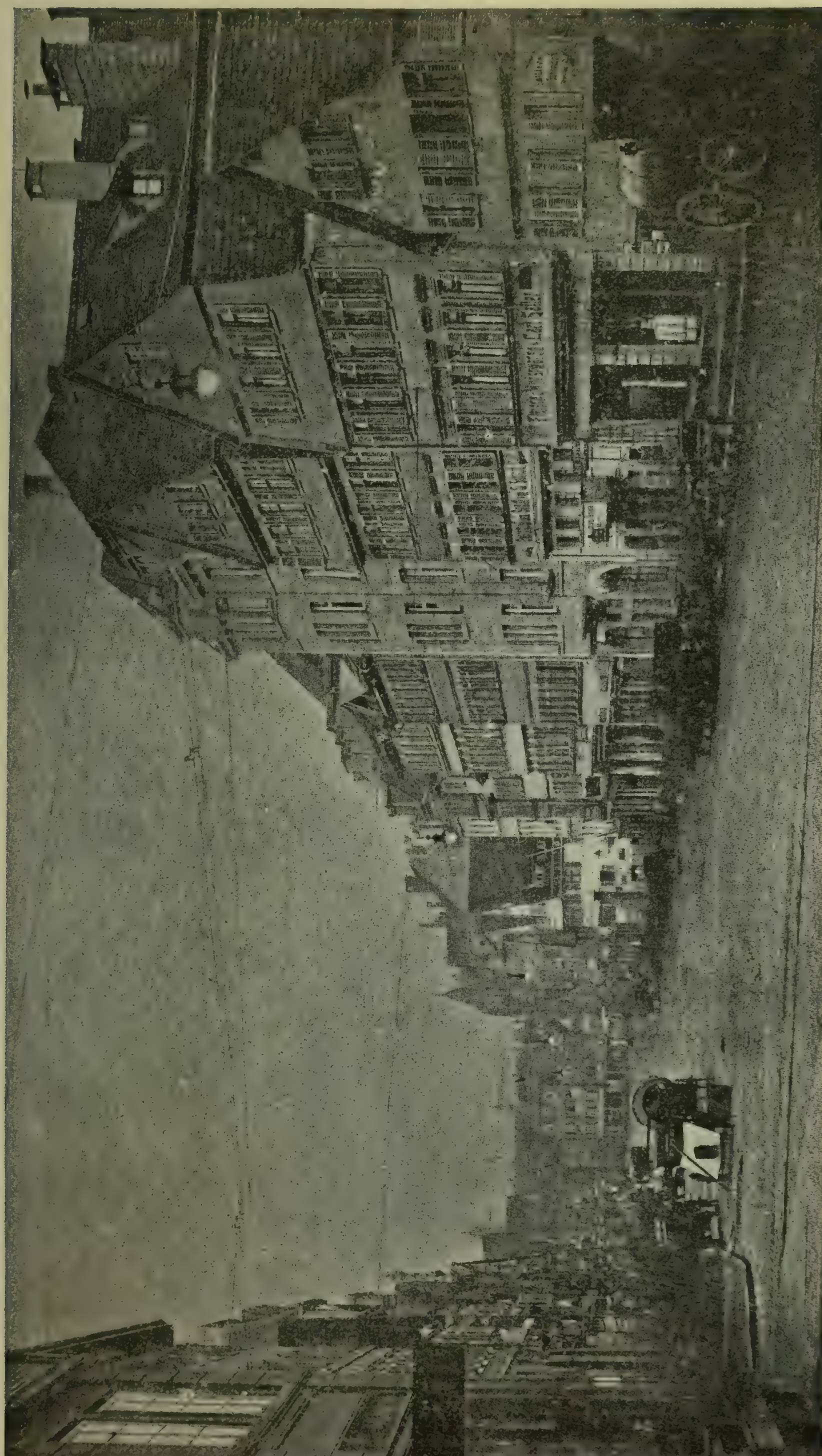
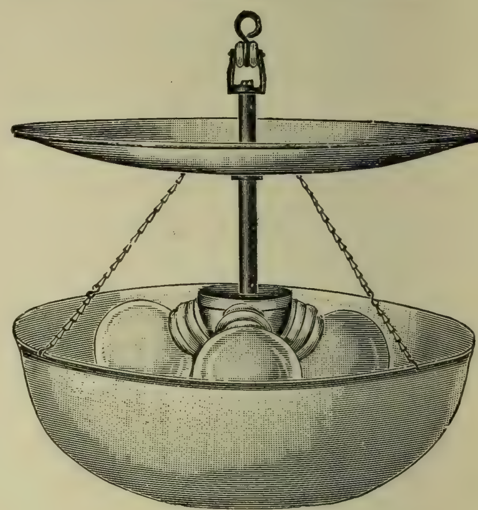


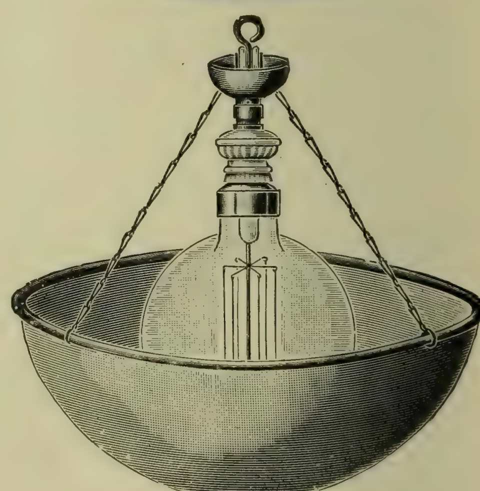
FIG. 3.—Illumination of street in Stuttgart by high pressure incandescent gas lamps strung on wires spanning the roadway.

Indirect Lighting with Metallic Filament Lamps.

It has often been pointed out in these columns how desirable it is in the case of bright illuminants that some means of shading direct rays from the eye should be utilized. This is now becoming generally appreciated in connexion with the metallic filament lamps, and it is interesting to observe that fixtures are being introduced which act on the indirect systems. Until recently it was hardly worth while to apply this method with glow lamps, owing to the fact that only lamps of comparatively low candle-power were available. More recently, however, the introduction of tungsten lamps of 200, 400, or even 1,000 candle-power has removed this difficulty.

The accompanying two illustrations refer to the "Eclipse" fitting now supplied by **G. Braulik** (8, Lambeth Hill, London, E.C.). These fixtures are made for use both with single high candle-power lamps of 200 to 400 candle-power or for clusters for lamps of smaller intensity. They are also utilized both with and without enamel reflectors above the lamp, and, it is stated, have already been applied with success in many hospitals, drawing offices, schools, &c.





Miniature Posters.

Messrs. Siemens Brothers inform us that, owing to the exceptionally large demand, they have been compelled to obtain a fresh supply of their "Satisfied Consumer" adhesive labels, which refer to the merits of tantalum lamps. These are supplied free of charge to the electrical contractor, and are suitable for attaching to correspondence, packages, &c.

A New Type of "Tantalum" Lamp.

Messrs. Siemens Brothers (Tyssen Street, Dalston) inform us that they are placing on the market a new and exceptionally interesting high-voltage "Tantalum" lamp for direct current, which will give 25 candle-power at an efficiency of 1·7 watts for all voltages between 200 and 240. The general appearance is similar to that of the 32 candle-power high-voltage "Tantalum" lamp to which we have already made reference. It is hoped that the new lamp, which is strong and durable, will be a great boon to contractors who have been faced with the problem of supplying private consumers with a comparatively low candle-power lamp which would burn direct on high-voltage supply.

Messrs. Siemens Brothers are issuing a new leaflet 14B, dealing exclusively with this lamp, and will be pleased to overprint a supply for any electrical contractor or ironmonger on receipt of his trade card.

Review of the Technical Press.

ILLUMINATION.

Most of the articles dealing with illumination that have appeared during the last month do not call for any detailed comment.

The subject of STREET LIGHTING continues to receive attention. **L. Bloch** (*E.T.Z.*, July 29), contributes a comprehensive article summarizing recent improvements in this direction both gas and electric. An editorial in a recent number of *The Electrical World* deals with the same subject from the municipal point of view. In a recent number of *The Builder* attention is called to the need for closer attention to the ORNAMENTAL APPEARANCE OF LAMP-POSTS in the streets. Much of the illuminating apparatus in use, it is pointed out, is somewhat unsightly during the daytime, when its real purpose is in abeyance. In the past men were perforce content with relatively poor methods of illumination, but they were willing to bestow considerable care and thought on the artistic appearance of the lanterns, &c., used, and were in many respects more successful than are we to-day. Naturally this is a matter which architects and others concerned would do well to take up; at present the engineer receives very little guidance from those who understand the artistic design of such structures, and therefore is sometimes apt to lose sight of the æsthetic in the practical.

An article by **Dr. H. T. Parsons** (*Science Progress*, July) deals with the question of the EFFECT OF TOO BRIGHT LIGHT ON THE EYES. The author reviews the effect of the ultra-violet rays, &c. and their possible effect in causing cataract, &c., and also insists upon the need for shading down the great intrinsic brilliancy of illuminants of to-day.

The CANTOR LECTURES on MODERN METHODS OF ILLUMINATION recently delivered by **Mr. L. Gaster,** editor of *The Illuminating Engineer*, before the Royal Society of Arts are now being published in full in the journal of the Society. The first three lectures are appearing in the numbers for Aug. 6, 13, 20, and 27, and the remaining lecture is to be published in the two following numbers.

PHOTOMETRY.

A number of interesting communications dealing with this subject have appeared. **J. Cady** (*Elec. World*, July 22) discusses a METHOD OF AVOIDING THE COLOUR DIFFICULTIES involved in comparing TUNGSTEN AND CARBON FILAMENT LAMPS and other sources. This involves interposing a suitable coloured screen between one side of the photometer and the source so as to bring the colour of both sides of the photometer screen into agreement.

The same difficulty forms the subject of correspondence by **Abady, Wild,** and **Lauriol** (*Electrician*, July 30, Aug. 6) in which the recent article by Wild in the same journal is discussed. Abady pertinently points out that we are not justified in assuming that photometers of the ordinary variety are correct, any more than flicker instruments, when it comes to the comparison of lights of different colour.

A very complete article by **U. Bordoni** (*Atti della Assoc. Ellettr. Ital.*, May–June) deals generally with the subject of COLOUR PHOTOMETRY. This is one of the most up to date articles on the subject that have yet appeared, many of the most recent contributions on the subject being mentioned, and the present knowledge of colour photometry summarized.

Other recent articles by **Krüss, Brodhun,** and others in the German papers again deal with the question of the INTERNATIONAL UNIT and the relative merits of the Hefner and Pentane lamps. While no objection is raised to the existing numerical relations established, it is still insisted that we cannot, strictly speaking, possess an international unit of light without an international standard, and that it is therefore better to refrain from formally bestowing the term "international unit" on the new value agreed upon, pending agreement on the ideal primary standard of the future; this, of course, does not detract from the convenience and practical utility of the present arrangement.

E. Presser discusses the utilization of selenium in photometry (*Schweiz, E.T.Z.*,

Aug. 14). He summarizes the work of Siemens, and other workers in this field and points out that many peculiarities in the behaviour of this substance render it almost impossible to use it *directly*: on the other hand, he thinks that selenium cells may be conveniently used for *comparative* measurements and for lights of the same colour, and describes its application in this field. Its value for heterochromatic comparisons is more doubtful, but in any case such measurements are to some extent arbitrary.

A recent number of the *E.T.Z.* (Aug. 5) contains some account of the wide scope of the work to be undertaken by the committee on photometry of the *Verband Deutscher Elektrotechniker*: a new committee has now been appointed.

ELECTRIC LIGHTING.

A number of recent articles and papers notably those of **Leonard, Turpain** and **Nicouleau,** and **Beringer** (see references in bibliography at end), describe researches on metallic filament lamps. That by Turpain and Nicouleau contains full details of life-tests on various types of lamps.

Other short articles in *l'Electricien* refer to recent types of arclamps and **Cheveneau** (*La Revue Electrique*, July 30) describes some elaborate experiments on oscillatory phenomena in the arc.

V. Paetou (*E.T.Z.*, July 29, Aug. 5) contributes an interesting article dealing with modern stage lighting apparatus. He lays special stress on the need for some central means of controlling all the different fittings simultaneously and points out the value of inverted lighting, especially for the production of special effects by the use of coloured reflecting surfaces.

T. Haydn Harrison *Electrical Times*, July 8, 15) makes some comparisons of the Cost of Gas and Electricity for lighting under average modern conditions. He finds that the actual cost is now not widely different, and therefore suggests that the greater convenience of electric lighting will still give it the advantage for interior lighting: his conclusions, however, are criticized by **Abady** in a subsequent letter to the above journal.

J. A. Seager (*Illum. Eng.*, N.Y., August) deals with Electric Illumination Topics in Great Britain; much of this article refers to the formation of the Illuminating Engineering Society in this country.

A. Pfeiffer (*Z.f.B.*, July 20) describes an Improved Method of Testing the Vacuum of Glow-lamps by the induction-coil discharge method.

A recent article in *The Electrical Review* deals with Selfridge's Installation, special stress being laid on the avoidance of naked lamps in the field of vision and absence of glare.

C. R. McKay (*Elec. World*, N.Y., Aug. 5) deals with the Titanium Arclamp. In the ordinary magnetite arc three chief metallic elements, Iron, Chromium, and Titanium are introduced to give conductivity, life, and brilliancy respectively. The arc described uses electrodes composed mainly of titanium carbide, and is said to yield about 0·56 watts per M.S.C.P., the electrodes lasting 70–80 hours.

GAS, OIL, ACETYLENE, &c.

The discussion of the Measurement of Calorific Power of Gas and its bearing on the performances of incandescent gas lamps still continues. A recent number of the *Journal of Gaslighting* publishes an account of some researches of **Mons. St. Claire Deville,** to which reference was made in a recent number of this journal. In addition attention is called to the recent utterances by **Dr. F. Clowes** regarding the advisability of a calorific standard (*G. W.*, July 31).

Several recent papers deal with Incandescent Gas Lighting. The lecture by **Mr. H. O'Connor** (*J.G.L.*, August 24) on this subject brings out several points of interest. For instance, it is stated that it is always desirable to secure fresh mantles, as mantles in stock tend to deteriorate. In addition it is frequently advantageous to use small mantles rather than large ones, not only because they are more durable, but also because the flame-volume is reduced and the luminous efficiency and mantle may be considerably improved thereby. For instance, it is stated that, with the same consumption of gas, a duty of 15 candle-power per cubic foot of gas can be improved to as much as 39 candle-power per cubic foot by using a much smaller mantle. Another interesting point was the suggestion of the lecturer that, on account of the different quality of different gas in different districts a burner which was good in one town might be a failure in another. This latter point was dwelt upon by **Lebeis** (*J.f.G.*, August 14), who also describes a type of thermal apparatus by which the admission of air to the burner is automatically regulated according to the quality of gas and the time it has been burning. This consists merely of a small flap which expands with heat and covers, to a greater or less degree, the holes through which the air is admitted to the burner.

Several communications deal with Distance Gas Lighting. Among these may be mentioned the article by **J. A. Seager** in *The Illuminating Engineer* of New York (August). In this article the various chief methods in practical use are reviewed. Recent numbers of the *Zeitschrift für Beleuchtungswesen* also contain a general article describing different kindling devices. In this connexion we may also mention an article dealing with the application for Electric Ignition to Acetylene (*Acetylene Journal*, Aug.).

Among other matters the account of a form of metallic filament incandescent mantles (*J.G.L.*, Aug. 24) is interesting. Such mantles are stated to be only about 1½ inches long. They are formed by depositing the metal molybdenum on a core of mixed metals. The efficiency attained with the pressure of 1½ inches is said to be 85 candle-power per cubit foot, and it is hoped to reach a useful life of about 2,000 hours. In addition the use of metal makes the mantle much less fragile.

Another recent development of some interest is the Twin Burner described in a recent number of *The Gas World* (July 31). This contains an upright and inverted burner mounted together on the same tube. The inverted mantle is immediately underneath the upright one, and both are fed by the same supply of gas ; it is also said that a very large portion of the products of combustion from the lower mantle encircle the upper one, and, in short, we practically succeed in running both mantles for the gas-consumption of one. The scientific explanation of the burner is puzzling, but it is said to be giving satisfactory results from the practical point of view.

Another subject which has again received attention in several quarters is the maintenance of Satisfactory Conditions between Company and Consumer. As an example of this it is interesting to observe that the Croydon Gas Company has adopted a free maintenance system according to which the lights of consumers are regularly attended to free, the only charge being for renewals.

Recent numbers of the *Zeitschrift für Beleuchtungswesen* contain a number of short notes dealing with developments in gas lighting, such as globes for high pressure burners, horizontal "Tubus" burners, &c.

Some articles in *The American Gas Light Journal* (July 26) deal with Shop Window Lighting and Sign Lighting by Gas. In this connexion reference is made to the use of concrete signs provided with small holes through which the gas issues. It is stated that the concrete can be easily made into any form desired, and that such signs lend themselves better to decorative treatment than do those built up of metal tubing in the ordinary way.

List of References:—

ILLUMINATION.

Bloch, L. Fortschritte der Strassenbeleuchtung (*E. T. Z.*, July 29, Aug. 5, 12).
Curtis. Lamps for Residence Illumination (*Elec. Rev.*, N.Y., Aug. 7).
Editorials. The Physiological Effects of Illumination (*Electrician*, July 30).
The Cost of Municipal Street Lighting (*Elec. World*, Aug. 5).
The Nat. Elec. Light Convention—Study of Colour—Third Annual Convention of the Illuminating Engineering Soc.—International Acetylene Assoc. (*Illum. Engineer*, N.Y., August).
Elliott, E. L. Illumination and the Electrical Contractor (*Elec. Rev.*, N.Y., July 31, Abstract).
Gaster, L. Modern Methods of Illumination (Cantor Lectures delivered before the Royal Society of Arts, *Journal* of the Society, Aug. 6, 13, 20, 27).
Parsons, Dr. H. T. The Deleterious Effects of Bright Light on the Eyes (*Science Progress*, July).
London's Electric Light Standards—A Study in Incongruity (*The Builder*, Aug. 21).
Printing and Illumination (*Elec. World*, N.Y., July 29).
Some Notable Installations, The Seats of the Mighty (*Illum. Eng.*, N.Y., Aug.).
The Hudson Fulton Celebration (*Elec. Rev.*, N.Y., Aug. 7).

PHOTOMETRY.

Abady, Wild, Lauriol. The Photometry of Different Coloured Lights (*Electrician*, July 30, Aug. 6).
Brodhun, E. Hefnerlampe u. Zehnkerzen-Pentanlampe (*J. f. G.*, July 31).
Bordoni, A. Sulla Fotometria Ellettrotecnica (*Atti della Associazone Ellettrotecnica Italiana* May-June, 1909).
Cady, J. E. Uniformity in the Photometry of Coloured Light Sources (*Elec. World*, N.Y., July 22).
Editorial. Colour-Screens in Colour Photometry (*Elec. World*, N.Y., Aug. 5).
Standards of Luminous Intensity (*Elec. World.*, N.Y., Aug. 5).
The Proposed International Unit of Light (*J. G. L.*, Aug. 17).

Krüss, H. The So-called International Unit of Light (*J. f. G.*, Aug. 14; *J. G. L.*, Aug. 17).
Presser, E. Neuere Fortschritte auf dem Gebiete der Selenphotometrie (Schweiz, *E. T. Z.*, Aug. 14, 21).
The Hefner and Harcourt Lamps Compared (*J. G. L.*, Aug. 3, 1909).
Verband Deutscher Elektrotechniker (appointment of new Committee on Photometry) *E. T. Z.*, Aug. 5).

ELECTRIC LIGHTING.

Aliamet, M. Nouvelle Lampe à Arc (*L'Electricien*, Aug 7).
Beringer, A., and Schuster, R. Umtersuchungen an Wolframlampen (*Z. f. B.*, Aug. 20).
Chèveneau. Experience sur l'Arc Electrique (*La Revue Electrique*, July 30).
Editorials. Electric Lighting in Germany (*Electricity*, July 2).
Metallic Filament Lamps (*Electricity*, July 2).
Harrison, Haydn. Gas *v.* Electric Light (*Elec. Times*, July 8, 15).
Kermond, de. La Lampe à Arc Sywa (*L'Electricien*, July 10, 31).
Leonard. Die Kohlenfadenlampe in vergleich zu den neueren Lampen mit erhöhtem Wirkungsgrad (*Z. f. G.*, July 10, 20).
Mather, F. T. Residence Lighting (*Elec. World*, N.Y., Aug. 5).
McKay, C. R. The Titanium Carbide Arc Lamp (*Elec. World*, N.Y., Aug. 5).
Paetow, V. Moderne Bühnenbeleuchtung (*E. T. Z.*, July 29, Aug. 5).
Pfeiffer, A. Die Vakuum Prüfung von Glühlampen (*Z. f. B.*, July 20).
Seager, J. A. Electric Illumination Topics in Great Britain (*Illum. Eng.*, N.Y., Aug.).
Turpain, A., and Nicoleau, H. Lampes à Incandescence (*La Revue Electrique*, July 30).
Die Popularisierung der elektrichen Beleuchtung (*E. T. Z.*, July 22).
The Electrical Installation of Selfridge's (*Elec. Review*, Aug. 20).
Preparation des filaments à Tungsten (*L'Electricien*, July 17).

GAS, OIL, AND ACETYLENE LIGHTING.

Armstrong, G. H. Display-Windows and Showrooms for Gas Companies (*Am. Gaslight Jour.*, July 26; *Prog. Age*, Aug. 16).
Deville, Sainte Claire. Heat of Combustion and Illuminating Power of Gas (*J. G. L.*, Aug. 10).
Editorials. Dr. F. Clowes on Calorific Tests for London Gas (*G. W.*, July 31).
The Inverted Burner (*J. G. L.*, Aug. 24).
Lebeis. Fortschritte der Invertgasglühlicht und Starklicht-beleuchtung (*J. f. G.*, Aug. 14).
O'Connor, H. Inverted Incandescent Lights (*G. W.*, Aug. 14; *J. G. L.*, Aug. 24).
Seager, J. A. Distance Control of Gas-Lighting in England (*Illum. Eng.*, N.Y., Aug.).
Presidential Addresses to Societies of Gas Engineers (*Le Moniteur de l'Industrie du Gaz*, July 31).
Perfuming Mixed Gas (*G. W.*, Aug.).
The Twin Light Burner (*G. W.*, July 31).
Victims of Illumination in Germany (*J. G. L.*, Aug. 10).
A Model Gaslighted and Heated Home (*J. G. L.*, Aug. 10).
Free Maintenance (*J. G. L.*. Aug. 24).
Electric Ignition with Acetylene (*Acetylene Journal*, Aug.).
Gasoline and Acetylene Lighting (*Acetylene Journal*, Aug.).
Air Gas and other Illuminants (*J. G. L.*, July 27).
Metallic Filament Gas Mantles (*J. G. L.*, Aug. 24).
Horizontal Glühlicht—Glocke für hängende Pressgasbrenner—Kugelgelenk für gemeinsame Gas und elektrische Leitung (*Z. f. B*, July 20, 30).
The Application of Acetylene to Trainlighting (*Acetylene*, Aug.).
Gas-zundvorrichtungen (*Z. f. B.*, Aug. 10, 20).
Gas-Illuminated Concrete Advertising Signs (*Am Gaslight Jour.*, July 26).
Extension of Artistic Show Window Lighting (*Am. Gaslight Jour.*, Aug. 16).

CONTRACTIONS USED.

E. T. Z.—*Elektrotechnische Zeitschrift.*
Elek. Anz.—*Elektrotechnischer Anzeiger.*
G. W.—*Gas World.*
Illum. Eng., N.Y.—*Illuminating Engineer of New York.*
J. G. L.—*Journal of Gaslighting.*
J. f. G.—*Journal für Gasbeleuchtung und Wasserversorgung.*
Prog. Age.—*Progressive Age.*
Phys. Rev.—*Physical Review.*
Z. f. B.—*Zeitschrift für Beleuchtungswesen.*

CORRESPONDENCE.

The Sand Blast Analogy of Distribution of Light.

DEAR SIR,—I have noticed with interest Dr. Bloch's method of illustrating the distribution of light in space by reference to a sand blast throwing out sand in all directions. Many engineers have probably felt the need for some concrete analogy by which to make these matters clear to non-technical people, and Dr. Bloch is rendering service in attempting an explanation on these lines.

At the same time there seems to me to be one respect in which the use of this particular illustration might be confusing to people without technical and scientific knowledge. The effect of a sand-blast introduces the idea of time. That is to say, the non-technical man might be confused by the fact that the thickness of the deposit of sand depends not only on the intensity of the blast, but also on the *time* during which it is allowed to play on a surface. On the other hand the *illumination* of a surface due to a steady source of light remains the same, however long it is applied.

Possibly a more convenient analogy from this point of view might be presented by a jet of air or steam playing on a surface which could be deformed by a pressure upon it. The amount of deformation would thus be an indication of the intensity of the pressure in any direction, and would be quite independent of the time; on the other hand, this method is open to the objection that the change in shape might not, in fact, be strictly proportional to the intensity of the pressure, though it would be essential to make this supposition.

Yours truly,

ATHOS.

PATENT LIST.

COMPLETE SPECIFICATIONS ACCEPTED OR OPEN TO PUBLIC INSPECTION.

I.—ELECTRIC LIGHTING.

14,852/08. Titanium filaments for incandescent lamps. July 13, 1908. Accepted July 21, 1909. C. Trenzen and F. R. Pope, 322, High Holborn, London.

14,853. Metallic filaments for incandescent lamps. July 13, 1908. Accepted July 21, 1909. C. Trenzen and F. R. Pope, 322, High Holborn, London.

16,722. Arc control mechanisms for search-lights, &c. Aug. 8, 1908. Accepted July 28, 1909. The British Thomson-Houston Co., Ltd., 83, Cannon Street, London. From General Electric Co., U.S.A.

21,834. Mercury and other vapour lamps. Oct. 15, 1908. Accepted July 28, 1909. H. A. Kent, H. G. Racell, and The Silica Syndicate Ltd., 47, Lincoln's Inn Fields, London.

27,523. Shade devices for incandescent lamps (C.S.). Dec. 18, 1908. Accepted Aug. 5, 1909. C. W. Frauenlob, 4, Corporation Street, Manchester.

425/09. Mounting electric lamps. Jan. 7, 1909. Accepted July 28, 1909. H. Girard, 7, Southampton Buildings, London.

1,541. Preventing flickering in arc lamps with parallel carbons (C.S.). I.C. July 18, 1908. Germany. D. Timar and K. von Dreger, 7, Southampton Buildings, London. Addition to 12,656/08.

3,252. Flash lamps (C.S.). Feb. 10, 1909. Accepted July 21, 1909. W. D. Whyte, 100, Wellington Street, Glasgow.

3,897. Incandescent lamps. Feb. 17, 1909. Accepted July 28, 1909. E. Böhm, 45, Hillmarten Road, London.

5,544. Systems of lighting for railway trains (C.S.). March 8, 1909. Accepted Aug. 11, 1909. Siemens Bros., Dynamo Works, Ltd., F. G. Broadhead, and T. F. Wall, 139, Queen Victoria Street, London.

6,429. Working arcs in series (C.S.). Mar. 17, 1909. Accepted July 28, 1909. H. Pauling, 31, Bedford Street, Strand.

15,192. } 15,193. } Filaments for incandescent lamps (C.S.). I.C. July 18, 1908, France. Soc. Française d'Incandesence par le Gaz (Système Auer), 24, Southampton Buildings, London.

15,210. Attaching filaments of incandescent lamps (C.S.). I.C. July 22, 1908, France. J. Canello, 7, Southampton Buildings, London.

16,309. Producing stage lighting effects by high frequency high tension currents (C.S.). I.C. July 16, 1908, Germany. F. Zhaniel, 20, High Holborn, London.

18,328. Flame arc lamps (C.S.). I.C. Aug. 11, 1908, Germany. Siemens Schuckertwerke G. m. b. H., Birkbeck Bank Chambers, London.

II.—GAS LIGHTING.

1,048/09. Incandescent burners. Jan. 15, 1909. Accepted Aug. 18, 1909. J. B. Colbran, 165, Queen Victoria Street, London.

4,860. Incandescent mantles (C.S.). Feb. 27, 1909. Accepted Aug. 5, 1909. J. W. L. Fisk, 33, Castle Arcade, Cardiff.

5,117. Lighting and extinguishing burners at given hours (C.S.). I.C. Mar. 18, 1908, France. Accepted Aug. 11, 1909. E. de Gonnevitch, 111, Hatton Garden, London.

5,260. Incandescent mantles (C.S.). Mar. 4, 1909. Accepted July 28, 1909. J. Fellner, 88, Chancery Lane, London. From Oberfelt & Co., Germany.

6,700. Anti-vibration burner for incandescent mantles. Mar. 20, 1909. Accepted Aug. 18, 1909. J. Dulton and W. A. Newhouse, 24A, Church Bank Buildings, Bradford.

11,371. Lighting and extinguishing gaslights from a distance (C.S.). I.C. May 14, 1908, Sweden. Accepted Aug. 11, 1909. J. F. Nässén and A. E. T. Bergström, 65, Chancery Lane, London.

16,091. Inverted burners for incandescent lamps (C.S.) I.C. July 31, 1908, Germany. E. Kirschke, 7, Southampton Buildings, London.

16,341. Lighting gas burners electrically (C.S.). I.C. July 13, 1908, France. M. Delage and P. Woog, 24, Southampton Buildings, London.

17,325. Inverted incandescent gasifying burners (C.S.). I.C. July 25, 1908, Germany. A. Huff and O. Huff, 116, High Holborn, London.

17,771. Filaments suitable for mantles in incandescent lamps (C.S.). I.C. Aug. 1, 1908, France. R. Laigle, 18, Southampton Buildings, London.

III.—MISCELLANEOUS.

(including lighting by unspecified means, and inventions of general applicability).

15,456/08. Illuminated sign characters (C.S.). July 21, 1908. Accepted July 21, 1909. R. R. Wiley, W. K. Wiley, and W. S. Hough, Jun., 6, Lord Street, Liverpool.

17,706. Shade holders for electric and other lights. Aug. 24, 1908. Accepted July 28, 1909. W. A. G. Hill, 116, Waterloo Street, Oldham.

17,794. Intermittently illuminating advertising apparatus (C.S.). Aug. 25, 1908. Accepted July 28, 1909. E. J. Day, 65, Chandos Road, Stratford.

18,163. Luminous sign or advertising device. Aug. 29, 1908. Accepted July 28, 1909. C. Wilson and C. Beaven, Brook Green Works, Hammersmith.

18,408. Means for suspending and varying the position of electric and other lights. Sept. 2, 1908. Accepted Aug. 11, 1909. G. Thomson, 122, George Street, Edinburgh.

19,705. Shade carrier. Sept. 19, 1908. Accepted July 28, 1909. J. Nelson and Drake & Gorham, Limited, 66, Victoria Street, Westminster.

22,964. Securing globes or shades in the galleries of electric light and other fittings. Oct. 28, 1908. Accepted Aug. 5, 1909. S. Falk, 4, South Street, Finsbury.

27,341. Pyrophorus substances for ignition and illumination (C.S.), Dec. 16, 1908. Accepted Aug. 5, 1909. A. Lesmüller, 20, High Holborn, London.

5,312/09. Oil lamps. Mar. 4, 1909. Accepted July 28, 1909. W. J. Lee, 53, Chancery Lane, London.

EXPLANATORY NOTES.

(C.S.) Application accompanied by a Complete Specification.

(I.C.) Date applied for under the International Convention, being the date of application in the country mentioned.

(D.A.) Divided application : date applied for under Rule 13.

Accepted.—Date of advertisement of acceptance.

In the case of inventions communicated from abroad, the name of the communicator is given after that of the applicant.

Printed copies of accepted Specifications may be obtained at the Patent Office, price 8*d*.

Specifications filed under the International Convention may be inspected at the Patent Office at the expiration of twelve months from the date applied for, whether accepted or not, on payment of the prescribed fee of 1*s*.

N.B.—The titles are abbreviated. This list is not exhaustive, but comprises those Patents which appear to be most closely connected with illumination.

Some Publications recently Received.

Methods of Determining the Amount of Light scattered from Rough Surfaces.—A New Form of Polarimeter for the Measurement of the Refractive Index of Opaque Bodies. (Two communications to the Royal Society of Dublin.) By Prof. W. F. Barret, F.R.S.

Atti della Associazione Elettrotecnica Italiana, May–June, 1909.—This number contains an article by U. Bordoni on electrotechnical photometry.

Among other publications received during the past month mention may be made of :—

Proceedings of the American Philosophical Society, Proceedings of the American Institute of Electrical Engineers, Journal of the Franklin Institute, Journal of the Institution of Electrical Engineers, Physical Review, &c.

The
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EDITORIAL.

The Third Annual Convention of the Illuminating Engineering Society.

As we write these words the Third Annual Convention of the Illuminating Engineering Society is taking place in New York. In our present and last numbers a list of the chief papers will be found on this occasion (pp. 648, 720), and we hope in our next number to refer to the proceedings in greater detail.

On a corresponding occasion last year we drew attention to the varied nature of the papers presented at the Annual Convention of 1908, and the wide range of subjects which they covered. The same may be said, and with equal truth, of the programme of the present year. Any one reading over the list of these papers must be struck by the number of points of interest they present, which we are sure will be discussed in a perfectly friendly manner by those interested in all illuminants.

This is a matter on which we wish to dwell again in connexion with the future work of our Society in this country. The impression of some people that such a Society must give rise to acrimonious discussions has been shown to be based on an entirely wrong conception. We feel confident that a glance over the record and work of our friends in the United States will supply ample confirmatory evidence in this direction.

In passing we may refer to what seems a very desirable precedent in this Convention, namely, the organization of an *exhibition* of the most recent methods of illumination.

We may, perhaps, also allude to one other feature of this convention which is of considerable historic interest. On this occasion, for the first time, the societies in both countries have officially exchanged friendly greetings, and we in this country have conveyed to our friends in the United States our best wishes, and our sympathy with the principle of concerted effort in connexion with matters of illumination in future.

This is an illustration of the growing desire of societies in different countries to help one another and to learn from

the experiences of those working in different localities but for the same objects. We are glad to say that, as will be seen from the list of some of the Vice-Presidents and Corresponding Members of our Society, published elsewhere in this number, it has been found possible to establish the Society on an international basis.

We are also pleased to announce that Prof. S. P. Thompson, D.Sc. F.R.S., has kindly consented to act as the first President, which augurs well for the scientific status and future prospects of the Society.

The International Conference of the Press.

Apart from the value of technical publications, such as those for which the Illuminating Engineering Society are responsible, we, of course, recognize that matters of illumination are followed with keen interest by the general public; the non-technical press can thus render good services by pressing home important truths, and we should like to take this opportunity of expressing our willingness to render assistance to journals, all over the world, who are interested in any aspect of illumination and require more explicit information thereon.

Our desire to establish an international platform for the discussion of all matter relating to illumination naturally leads us to refer to the Conference of the Press, which is at present taking place in London. This and the previous year have been remarkable for the number of international congresses on various points which have taken place in this city, and every one should rejoice at this evidence of *rapprochement*.

Such congresses, having a special object, and therefore exceptional inducements to co-operate, are, perhaps, particularly well adapted to promote friendly relations between different countries. Most people theoretically desire that such relations should exist; but an abstract wish of this kind is not readily translated into fact unless there is *some common interest* to bring the different authorities together.

The coming together of those who have common subjects of thought on which to converse and common objects to be promoted, is often the means of forming a substantial friendship, which is not so readily brought about by ordinary social relations.

We may, therefore, conclude by expressing a very hearty welcome to our foreign guests, and a wish that they may find their visit in every way profitable and enjoyable. The writer has had the privilege of acting as the Hon. Secretary of the Reception Room and Hotel Committee, and had thus once more opportunity of coming in contact with leaders of the foreign and home daily press, and of satisfying himself as to the need of concerted international action in matters connected with illumination.

The Design of Lamp-posts in London.

We refer elsewhere in this number to an article dealing with the electric light standards in London which was recently published in *The Builder*. It is very interesting to observe the different types of designs that are prevalent in different parts of one and the same city. According to our contemporary their design has also proceeded on somewhat chaotic lines, and many of the existing fixtures leave much to be desired from the æsthetic standpoint.

Whatever be our convictions on this matter, it must be recognized that the subject which is thus commented upon by our contemporary is one which has not yet received the study it deserves, and it is quite probable that many of the designs could be improved considerably from an architectural standpoint without suffering in utility. It must always be remembered that, after all, such illuminating agents only do duty for a certain period of the night; in the daytime they are not exercising their function of illuminating the roadway, and yet they may be, all the

same, very prominent objects. The appearance of a street may be considerably marred by the erection of a series of lamp-posts, the design of which is intrinsically weak or out of harmony with the surroundings.

The suggestion that lamp standards should be designed in such a way as to harmonize with their surroundings is not one to be lightly dismissed, even though some degree of compromise on this point may be essential. It would also hardly be surprising if many of the present designs were open to objection, seeing how little opportunity the engineers primarily responsible for their design usually enjoy of studying the artistic side of the question. Yet there is no reason to suppose that truly artistic constructive lines might not be attained without increasing the expense of manufacture of the fixture. This problem, in short, offers an excellent illustration of one of the many fields in which the co-operation of the architect and the illuminating engineer might lead to very beneficial results. What is needed is some machinery for bringing both professions into friendly contact, and this machinery we may hope will be supplied by the Illuminating Engineering Society. It would, indeed, be very beneficial in this direction if the question of street lighting could be placed in the hands of a single central authority, which could exercise adequate supervision on these artistic and architectural points.

Another matter to which attention has also been recently paid is the possibility of utilizing some of the surplus light from street lamps in order to indicate the names of streets, &c. The present methods of indicating the names of streets and buildings, though doubtless constituting a very great improvement over the facilities available a few years ago, are usually so contrived as to be only of service in the daytime; when night falls they cannot be seen. Yet it is at this very period that the streets are crowded with people. It would seem, therefore, to be a simple and obvious suggestion to propose the use of clearly legible directions fixed to the lamp-post in the neighbourhood of the source of light, and so arranged as to be adequately illuminated by a little of the surplus light. This possibility, we are pleased to note, was recently emphasized in *The Builder's Journal.*

There are, of course, other conceivable developments of this idea. We note, for example, that an electric light company in the United States have offered to undertake the lighting of certain streets in one city free on condition that they are permitted to make use of the lamps for advertising devices. Another idea, worthy of imitation in this country, was noted by the writer in his recent visit to the Continent, namely, the use of certain lamps at definite intervals to indicate the stopping-places of electric trams on both sides of the road. At present one often finds that the indications of halting places are prominent by day, but are indistinguishable at a short distance away by night, and any one unacquainted with the locality runs a risk of missing his tram in consequence. This might be avoided by the simple expedient of attaching a prominent sign to certain lamp-posts so as to be properly illuminated by the lamp above it.

The Vienna Central Testing Institution for the Benefit of the Gas Industry.

The paper on Modern Photometry recently read by Prof. Strache before the Institution of Gas and Hydraulic Engineers in Austria-Hungary contained an announcement which illustrates very forcibly the tendency towards specialization in methods of photometric testing on the part of the gas industry of to-day.

The Society referred to have decided to form a central testing institution, equipped with the most up-to-date and complete photometrical apparatus, which will undertake tests and researches, at a moderate fee, for manu-

facturers or small gas works who have not at their command the somewhat elaborate facilities which such tests demand; this institution, we note, will be under the charge of Prof. Strache at the Technische Hochschule in Vienna, and will be organized in connexion with the Education Department.

This union of practical considerations and educational facilities seems, in principle, something much to be desired. Most of those who have studied the methods of technical education in this country have insisted upon the need of bringing practical conditions and theoretical acquirements into closer contact.

In this journal we have several times referred to the important precedent established by the creation of a special lectureship at Leeds University in memory of Sir George Livesey, and expressed the hope that the gas industry in this country would derive great benefit from the researches to be conducted, and give practical support to their prosecution. A direction in which manufacturers can give assistance is by the suggestion of lines of experiment on which further data are needed and by co-operating with the College authorities to enable the researches to be carried out on an adequate scale and under conditions which render the results arrived at readily applicable to practice. An example of foresight of this kind which occurs to us is furnished by the action of a firm in the United States who are interested in the manufacture of scientific illuminating glassware. This company, with the approval of the College authorities, founded a special research scholarship, on the understanding that the student accepting it should devote himself mainly to prosecuting certain lines of research in connexion with the improvement of glass shades, &c., the work required being essentially of a scientific nature, such as could most readily be carried out in the laboratory of a well-equipped college. As an example of such work we may mention the design of diffusing globes or reflectors to suit certain types of lamps, with which they are intended to be always associated, and in connexion with which they are sold as a single "unit," thus preventing the use of unshaded glaring sources of light of undesirably high intrinsic brightness. It was also understood that such students, having specialized early in this direction, would afterwards enter the employ of the company.

This seems to us a far-sighted policy, likely to be beneficial both to the company and the student. Whatever his class of work, a student, towards the end of his time at college, begins to ask himself what work he will take up when his course is completed. The knowledge that he has definite work in view must come as a great incentive to accumulate information and experience bearing on his special branch. It will, of course, be said that a student during his college course ought to avoid undue specialization. This is quite true, and a properly organized regular course prevents his doing so. But it is also of great benefit for him to feel that there is one department which he must make his *special* field of knowledge, and to this branch he may with advantage devote his post-graduate course. At the same time the suggestion of definite practical problems from without leads him to enter upon feasible researches which he feels have a definite practical value.

These remarks, of course, have a general bearing, and are not intended to apply exclusively to illuminating engineering. At the same time, we hope that facilities will be granted in the future for special researches of this character, which will naturally follow the organization of courses of study, intended to cover all branches of illumination in an impartial and comprehensive manner.

LEON GASTER.

Review of Contents of this Issue.

Mr. A. P. Trotter (p. 665) now takes up the subject of the measurement of illumination and ILLUMINATION-PHOTOMETERS. He describes some of the early types of instruments designed by himself and Sir Wm. Preece, and discusses the uses and the conditions with which instruments of this class ought to comply.

Dr. M. Gaster (p. 660) in the present instalment of his article traces the connexion between LIGHT AND THE GROWTH OF CUSTOM AND SUPERSTITION.

The author shows how the boundary line between faith and superstition is very fine, and points out how many religious ceremonials involving the use of fire and light have been indirectly instrumental in suggesting superstitious ideas.

The above contribution is followed by an announcement on behalf of the **Illuminating Engineering Society** that **Prof. S. P. Thompson** has kindly consented to act as FIRST PRESIDENT. A list is also given of some of the distinguished authorities in different countries who have agreed to act as Vice-Presidents and Corresponding Members of the Society. The opening session, it is contemplated, will commence next November.

An article by an Engineering Correspondent of the journal deals with the ILLUMINATION OF THE HOUSES OF PARLIAMENT (p. 663). The author traces the evolution of the lighting up to the present stage and illustrates his remarks by quotations from the archives of the time. Originally, it is stated, the feeling of the House was opposed to any alteration in the traditional method of lighting by candles, and it was only by degrees that the present improvements in lighting and ventilation met with toleration.

The paper recently delivered at the Annual Meeting of the Gas Institute by **Mr. A. Forshaw**, dealing with the ILLUMINATING EFFICIENCIES OF CARBON MONOXIDE AND HYDROGEN is continued on p. 663. In the present instalment some of the main results of the experiments are summarized and facts are quoted to show that the effects of using the two gases differ in several essentials, and notably in the distribution of light over the mantle in the two cases.

Mr. A. A. Wohlauer (p. 673) deals with the application of the "FLUXOLIGHT" PAPER to illuminating engineering, illustrating the process by reference to two problems involving the distribution of illumination in a street and round the edge of a table of given area.

The report of the deputation recently appointed by the Corporation to inquire into the METHODS OF LIGHTING IN VOGUE IN VARIOUS CONTINENTAL CITIES is concluded in this number (p. 677). In the present instalment the illumination of the cities of Paris and Brussels is briefly commented upon, and, in an appendix, the chief systems of lighting in London are summarized.

Dr. L. Bloch (p. 682) completes his article dealing with the SIMPLE CALCULATION OF PHOTOMETRIC QUANTITIES. The author first shows how the regular construction for the determination of the mean spherical candle-power of a source can be deduced by the aid of the "sand-blast" analogy, and summarizes the researches which have been made by various observers with the object of facilitating the process of calculation from a known curve of polar distribution of light. He also gives some new original formulæ by the aid of which this calculation can be still further simplified, and an approximate result very readily obtained.

A correspondent dealing with COLLIERY ILLUMINATION (p. 689) describes the chief types of lamps used

in collieries at the present day, and discusses the conditions with which an ideal lamp would have to comply. He also describes a type of lamp with which is combined an arrangement, based on gaseous diffusion, to enable the presence of fire-damp, &c., in the atmosphere to be readily recognized.

A paper by **Prof. Strache** (p. 695) deals with MODERN PHOTOMETRY. The author describes a number of types of photometrical apparatus in use at the present day, and explains their value as a means of investigating the qualities of various artificial illuminants. He concludes by alluding to the establishment of a Testing Institution in Vienna, at which such researches can be conducted for the benefit of manufacturers and others who lack the needful, somewhat elaborate apparatus.

A paper on STREET-LIGHTING FIXTURES, by **H. Thurston Owens,** read at the second Annual Convention of the Illuminating Engineering Society, will be found on p. 700. This summarizes the chief types of lamps available for street lighting, and draws attention to the different varieties of neighbourhoods to the illumination of which they are applied ; the paper is followed by discussion.

Among other articles in this number attention may be called to that on p. 708, which consists of a criticism of some of the TYPES OF ELECTRIC LIGHTING STANDARDS in use in London. Many of these designs, it is suggested, are open to objection from the artistic and architectural standpoint, and an attempt is made to indicate the lines on which improved design might profitably proceed.

The paper by **Mr. W. H. Fulweiler** on THE THEORY OF FLAME AND INCANDESCENT MANTLE LUMINOSITY is continued in this number on p. 705. In the present instalment the author concludes the section of the paper dealing with the theory of luminous flames and analyzes the contributions of different hydrocarbons to the light-yielding areas of the flame. Turning next to the incandescent mantle, he describes some of the early work of Drummond, Fahnehjelm, and others in this direction, and gives some account of the various theories that have been put forward by Killings, Bunte, and other scientists to account for the action of the modern mantle.

An article by **Dr. H. Kruss** (p. 710) describes A NEW FORM OF INTEGRATING PHOTOMETER based on the action of a series of inclined mirrors, the rays from which are received by appropriate lens-systems, and concentrated on a diffusing white surface. The factor "cos. θ" is introduced by appropriate "stopping" down of these lenses. This article is followed by a short note summarizing some of the speculations of **Dr. E. L. Nichols** and others on the subject of PHOSPHORESCENCE AND LUMINESCENCE.

Among other articles in this number mention may be made of that dealing with the ILLUMINATION OF THE WHITE HOUSE, WASHINGTON, U.S.A. (p. 680). The illumination of the avenues and the surroundings of the house is of a special nature, in order that all people approaching the house may be scrutinized before admission. The interior lighting of some of the rooms is accomplished by massive chandeliers.

Mr. C. C. Paterson contributes a letter to our correspondence columns on the subject of the proposed name for the INTERNATIONAL UNIT OF LIGHT. He suggests that there are several reasons for considering that the name "Violle," as proposed by M. Blondel, should preferably not be employed in connexion with the present unit.

At the end of this number will be found the usual **Review of the Technical Press** and the **Patent List.**

TECHNICAL SECTION.

[*The Editor, while not soliciting contributions, is willing to consider the publication of original articles submitted to him, or letters intended for inclusion in the correspondence columns of 'The Illuminating Engineer.'*

The Editor does not necessarily identify himself with the opinions expressed by his contributors.]

Illumination, Its Distribution and Measurement.

By A. P. Trotter,

Electrical Adviser to the Board of Trade.

(*Continued from p.* 586.)

Illumination Photometry

The first section of these articles dealt with the theory of the distribution of illumination; the second gave an account of methods and apparatus used for the photometry of lights, or the measurement of candle-power. The consideration of the photometry of lights of different colours will be held over for the present, and the next section will deal with methods and apparatus used for the measurement of illumination. The concluding one will discuss results.

It may be well here to return to the consideration of the quantities which are to be measured. Candle-power is concerned with the emission of light. Illumination, on the other hand, is concerned with the reception of light. A piece of white paper and a piece of black velvet placed at a distance of one foot from a source of light of one candle power, and facing the source of light, each receive an illumination of one foot-candle. The fact that one appears brighter than the other depends of course on the reflecting powers of the surfaces. It is a mistake to say that the illumination of the white surface is greater than that of the black surface.

The candle-power photometer is an instrument for the factory or laboratory; its use is to give information about what a lamp can do. The illumination photometer is a portable instrument for use in all places where light is used—the street, the church, the school, the dining-room table, the railway station, the railway carriage. It is not concerned with the lamps, but with what the lamps do. Nor is it confined to the use of lamps and artificial light. It can measure diffused daylight; it can give accurate information about the degree of illumination at any point, and about the distribution of illumination over any place. By measuring the illumination of a well-lighted bank, knowledge is obtained for prescribing that illumination for another bank, but the photometer does not tell whether the lamps are so arranged that the clerks' eyes are dazzled.

In the original paper, of which these articles are an expansion, the photometers of Prof. L. Weber and of Prof. Mascart were briefly described as the first illumination photometers. This appears to be a mistake. Descriptions of these instruments were published in 1883, but as candle-power photometers; and it seems that they were not used for measuring illumination until a later period. These questions of priority are of very little importance. Credit may be given, though he has never claimed it, to Sir W. H. Preece for the invention of the first illumination photometer. In the last of an interesting series of Reports made by him to the Streets Committee of the Commissioners of

Sewers of the City of London, he writes, in August, 1884, "I made my standard the amount of illumination given by a British standard candle fixed at 12·7 inches distant. This is very easily reproduced, and it is the same illumination as that given by the French standard light when fixed at a metre distance.... Our instrument for the purpose must be light and portable, for it had to be moved about the streets. It required to be easily reproducible at any time and place, and to be absolutely uniform. I took my idea from the fairy lamps used at the Savoy Theatre in 'Iolanthe.' Here we had something portable, adjustable, uniform, and very easily manufactured. One of these lamps was placed inside a small box, the top of which had a screen of white paper on which was a grease spot. I was able, by increasing or diminishing the current of electricity producing the light, to vary the illumination of one side of this grease spot. When it was desired to measure the illumination of any space, such as the surface of a street, this box had simply to be put at the place to be measured, and the current had to be regulated until the grease spot disappeared. The current of electricity then became the measure of the illumination, and a simple table gave the result in terms of the new standard."

Several forms of the apparatus had to be made before he obtained one which fully met his practical requirements. The method was described in a paper* read before the Royal Society on June 21st, 1883.

The Preece Illumination Photometer.

Fig. 90 shows a pattern slightly modified from the one illustrated in the paper. The illumination to be measured was received on a white paper screen parallel with the Bunsen screen and at about 12 inches distance from it. Experiments showed that the illumination corresponded closely with the sixth power of the current over a range of 1 to 64 in candle power, or 6 inches to 4 feet in the distance of the calibrating lamp from the reflecting screen. The lamps used were generally Swan $2\frac{1}{2}$ candle-power at 5 volts. As at that time there were no sufficiently sensitive ammeters or voltmeters, a differential galvanometer null method designed by Major P. Cardew was employed. The current to be measured passed through a few turns of thick wire, and the current from two large Leclanchè cells passed through a coil of many turns of fine wire. Resistance boxes with plugs were arranged in both circuits, the one for controlling the candle-power of the lamp, and the other for adjusting the current in the fine wire circuit of the differential galvanometer. The handling of the two sets of plugs for each measurement was

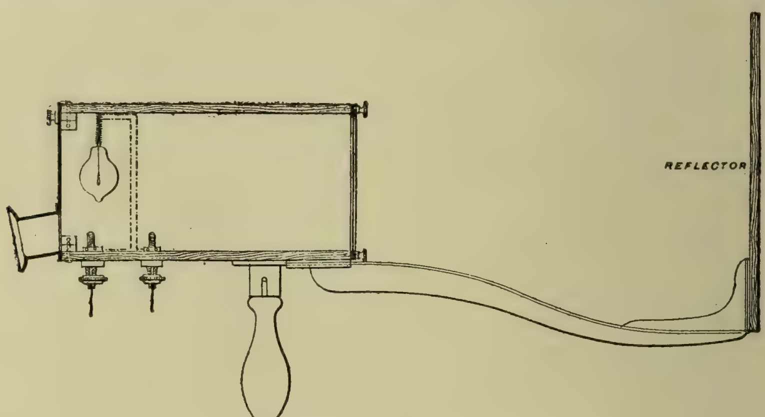


Fig. 90.—The Preece Illumination Photometer.

* *Proc. Royal Society*, No. 229, 1884.

tedious. The instability of a glow lamp as a standard of light was alluded to by Sir William (then Mr.) Preece in his original paper, but no perceptible change occurred in the course of an evening's work. The instrument was calibrated with standard candles. As the construction of the apparatus prevented the candle from being placed immediately in front of the screen, two candles were used, one on each side, and were arranged so that the angle of incidence on the screen was 60 degrees.

I had the privilege of assisting Sir W. H. Preece in his photometrical work, and helped to make many measurements of the illumination of the streets in the City of London, some of which were experimentally lighted, and well lighted, by electric light. Arc lamps on very tall posts were tried near the Mansion House, and Holborn Viaduct was lighted by 110-volt Edison lamps, the current being supplied from the celebrated "Jumbo" dynamo. The photometer showed that the illumination of the street fell off westwards, owing to the resistance of the mains. I regret that my note-books of that date have been recently destroyed by inadvertence, and I cannot give details of the work.

Modern critics of illumination photometers have suggested that the apparent brightness of screens made of such material as white paper does not follow the law of cosines. Sir W. H. Preece was quite alive to such a possibility, and in calibrating one of these photometers, I tried the experiment of moving the two candles so that the angles of incidence varied, while the illumination was kept constant. The candles had to be moved in a curve which was, within the errors of experiment (say, 8 or 10 per cent), a circle tangent to the screen, showing that for ordinary work of those days angle errors could be neglected. In street work, where the illumination due to several lamps was to be measured, the screen was naturally held horizontally so that each lamp should contribute its own illumination on a fair basis. The chief disadvantage of this first illumination photometer was that when feeble illuminations were measured the colour of the little lamp was too red, and with brilliant illumination there was risk of altering its candle-power by over-running. Sir W. H. Preece designed another photometer in which the lamp was made to approach or to recede from the Bunsen screen by means of a long screw. A large number of Bunsen spots of different kinds were tried, in the hope of finding one which could be viewed satisfactorily from one side only; but eventually, in a photometer designed by Sir W. H. Preece in collaboration with myself, we used the well-known arrangement of two mirrors, allowing both sides of the spot to be seen simultaneously. The lamp was mounted in a holder sliding on a vertical rod (see Fig. 91). It was moved by a lever.

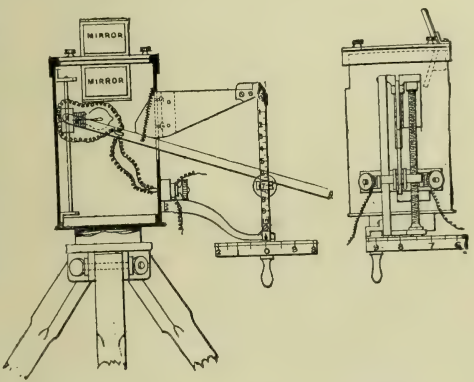


FIG. 91.—Preece and Trotter Illumination Photometer.

A rather strong spiral spring pulled one end of this lever and caused it to press upwards against a cam and downwards against a grooved wheel. This wheel was mounted on a nut which traversed a vertical screw. At the lower end of the screw there was a handle and a graduated wheel. A vertical uniformly divided scale enabled the position of the nut to be read. The cam was so shaped that when the nut moved through a given distance, the lever rolled along the cam and the displacement of the lamp was proportional to the square of that distance. A sliding resistance and an ammeter were used for maintaining the constant current required to balance the unit illumination. The defect of this and

of all illumination photometers which depend upon motion of the lamp is the small range attainable. In this instrument the range was only 1 to 10, but the range of the illuminations measured by Sir W. H. Preece in 1883-4 was from 2·5 to 0·01 of the unit used. It was mounted on a stand; the Bunsen screen was about 5 ft. from the ground.

After an interval of nearly eight years, during which nobody in this country had continued the study of illumination photometry initiated by Sir W. H. Preece, I took up the matter again, and after a considerable amount of experiment made the perforated screen photometer, the history of which is given in my paper of 1892* and in a recent article† of this series.

forated screen. The lamp was moved until an approximate balance was obtained, and then the cube and tube were raised clear from the ground, swung by cords in the plane of the lamp, and dropped at the best point. The illumination was read off on a tape graduated directly in foot-candles. In streets lighted with flat-flame gas burners an illumination of 0·005 foot-candle was not uncommon. This corresponds to a candle at 14 ft. 2 in. A complete tube connecting the lamp with the photometer was out of the question, and errors due to stray light undoubtedly caused the readings to be too low. I therefore proceeded to experiment with different methods of diminishing the light.

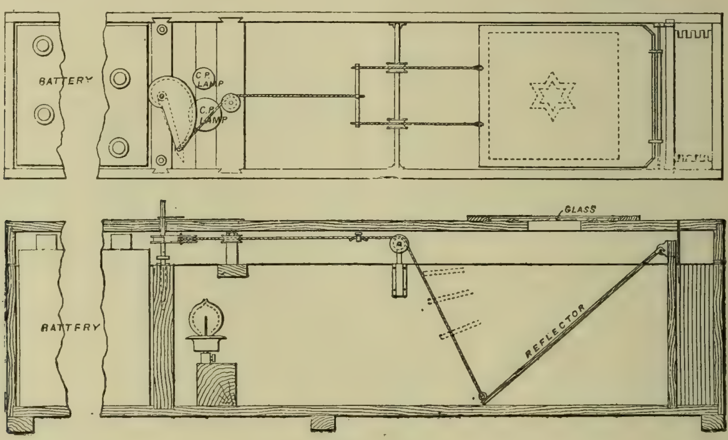


FIG. 92.

This was used in a very primitive fashion in the London streets in the winter of 1891 with the assistance of Messrs. J. Leggat, J. E. Pierce, and W. G. Wallace, then students at the Finsbury Technical College. The perforated screen formed the top of a 5-inch cube. Blackened cardboard tubes 5 inches square and from one foot to about 3 feet long were fitted to the open side of the cube, and laid on the street. A glow lamp, usually 1 candle power or ¾ candle power, supplied by accumulators, was set at 5 inches from the ground, so that its light could not fall on the under surface of the per-

In a paper by Mr. Preston S. Millar on 'Illumination Photometers and their uses,' read at the first annual Convention of the Illuminating Engineering Society of Boston, 1907,* the essential features of an illumination photometer are said to be "first a photometric device; second a comparison light source; third, a means of varying the intensity of the illumination produced upon the photometric device by the comparison light source; fourth, a test plate upon which the unknown light falls." In discussing the third of these features Mr. Millar writes: "This has been accomplished by a variety of methods,

* *Proc. Inst. of Civil Engineers*, vol. cx. pp. 101-4.

† *Illuminating Engineer*, vol. ii. p. 369.

* *The Illuminating Engineer of New York*, vol. ii. p. 475.

some of considerable ingenuity. These may be classified as follows. First, variation in distance, applying the inverse square law. Second, rotating sector discs, relying on Talbot's law. Third, inclination of an illuminated surface, applying Lambert's law of the cosine. Fourth, variation of the intensity of the comparison light source. Fifth, the use of absorbing media. Sixth, the use of variable diaphragms, generally with diffusing screens. Seventh, dispersion lenses. Eighth, polarization method."

I tried most of these devices. The variation of the intensity of the source of light, and the alteration in distance gave rise to difficulties which have been mentioned. Rotating discs needed, for their accurate adjustment while running, better workmanship than I could command, I made many experiments with lenses, both concave and convex, but found that a range of movement of at least 2 ft. 6 in. was necessary, and it was difficult even then to produce a uniform illumination on the reflecting screen. My inner screen was 3½ inches square, and the perforated screen receiving the illumination to be measured had a star-shaped hole 1¼ inch across. The comb eclipsing device used in "dissolving views" required fully two feet to secure uniform illumination, and an "iris" diaphragm was no better. Photographically shaded glass screens were tried, and a pair of lenses sliding over each other. This last device would have succeeded, but with low illuminations an image of the lenses appeared.

I finally adopted the method of inclining the inner screen at different angles. As at first arranged, the screen was mounted symmetrically on a horizontal axis and a pointer was geared to the axis in the ratio of 1 to 12. The readings for the higher illuminations were fairly good, but in spite of the gearing, the readings for low illuminations were too close together. The reflecting screen was then mounted on an axis passing through its upper edge, and motion was given to it by a fine chain wound upon a snail cam. The cam was shaped at first on the assumption that the illumination on the screen would be proportional to the cosine of the angle of incidence of the light upon it. This instrument is illustrated in Fig. 92.

In the plan showing it with the cover removed, the battery is seen on the left, the snail cam and chain (the cam being in the position for maximum illumination), and a 1 candle-power and a ½ candle-power lamp which could be used singly or together. The star-hole in the perforated screen is shown by dotted lines. On the right there was a compartment for spare or experimental screens. The sectional elevation shows the slope of the movable inner screen in the position for maximum illumination, and dotted lines show it in other positions. The instrument was about 6 inches high and was always placed on the ground. The star-hole was viewed directly from above. The dial, which is not shown in the illustration, was graduated almost completely round a circle, with an open but not quite uniform scale. It was of course calibrated by experiment. The cam was turned by a removable handle about a foot long, to save much stooping. Illumination from any direction except immediately overhead could be measured. Most of my work in the streets of London in the winter of 1891 and the spring of 1892 was done with this instrument.

(*To be continued.*)

Technical Guides at the Museum at Munich.

In a recent number of the *Elektrotechnische Zeitschrift* mention is made of an interesting development in the Technical Museum in Munich. Guides are to be engaged having special technical qualifications which enable them to explain fully all details of interest in connexion with the exhibits.

It is also stated that, for the benefit of the many foreign visitors to this museum, such guides will, if possible, possess a knowledge of several languages.

Light in Custom and Superstition.

By Dr. M. Gaster.

The boundary line between faith and superstition is so fine that it is often difficult to ascertain where the one finishes and the other begins. They shade imperceptibly off into one another. Nowhere stands the individual character of the opinion entertained and of the judgment passed more vividly out than in the appreciation of popular ceremonies. What to the one better informed is a clear and logical action based on reason and understanding, and fully compatible with our convictions and with the progress of civilization, appears with equal justice to another less informed and not sufficiently well acquainted with the origin and inner meaning as mere superstition. Knowledge as much as preconceived notion and prejudice mould our judgment and determine our opinion even where difference of place and faith do not contribute to influence our views. It is almost of the essence of dogmatic religion to stamp everything that differs from its forms as superstition, and to condemn it as something vicious and spurious.

One might have thought that in a matter so pure and so illuminating as light such differences could not subsist, and yet as soon as the fire had come within the purview of religion, and the use of it an essential element in religious worship, it was inevitable that it should also be contaminated by contact with matter. As soon as it assumed the grosser forms of earthly artificial existence some of the frailties of such an existence were imparted to it. First worshipped, it is then used also for other practices, and connected with other forms of beliefs in which the purer side had become somewhat obscured. In order to keep within close limits and not to fall into line with those with whom the word superstition is a familiar expression, I have preferred to discuss this phase of the fire worship under the heading of custom and superstition, leaving to every one his own choice.

The sacredness of the fire was in the first place, and logically, transferred to everything consumed by the fire. It partook of its sanctity, and nothing could be more pleasing to the deity, so it was believed, than to transform every gift into fire, and to light up by it the altars and the shrines. The lamp alone was not sufficient to do honour. Other gifts were also offered, and thus arose the ancient and modern practices of fire sacrifices, of kindling holy fires, and of burning on certain occasions some choice portions of human property. In remoter times the very human being was brought as a sacrifice, *i.e.*, was transfigured and transformed into a god by means of fire, and became, as it were, identical in its essence with the divinity to which it was brought as a token of thanks, or more often as a means to curry favour with the god and to obtain from him protection, or as the case may have been, the averting of evil and cure from diseases. Thus it came about that men gave up their children as offerings, and burnt them alive in honour of Moloch, and other less-known gods, and that the first-born of the King of Moab was burnt as an offering to obtain victory when the town was besieged by the enemy. Animals were then substituted, and in time herbs and sweet smelling gums and spices were burnt on the altars and in the temples. Frankincense and sandal wood, as well as amber and spice, are still burnt up in the performance of religious ceremonies, and the censor has become just as much part and parcel of divine worship as the lamp and the burning fire. It is all part of the fire worship transformed and enlarged upon the original simpler form of the worship of the sun and of

fire in general. How intimate that connexion has been between the worship of fire and the burning of fire as a means of appeasing the gods and of becoming identified with them is shown by numerous acts of self-consummation.

To be burnt on the pyre alive was to become associated with the gods, to partake of their nature. A few examples may suffice: Hercules, Croesus, Empedocles, or Peregrinus, who throws himself into the crater of the burning volcano, all assume thereby the character of gods and became immortal. And the burning of the dead bodies by the Brahmins and by the Greeks and Romans in olden times was not unconnected with the same idea of becoming thus the immediate associates of the gods. All that was mortal or belonged to matter was thus purified and sublimated in the proper sense of the word.

Other pyres were lit at a later time when people were forcibly sent up to heaven by being burnt alive, also as sacrifices; for it was claimed that it was done for the greater glory of God, for the salvation of their souls, and for saving them from the pollution of the darkness of heresy. In this case they were the true martyrs of light, and became associated with the immortals, like their predecessors in olden times, but with a difference; they were not left any choice, nor did they select this method of ascending on high riding on the flames. It was forced on them by others, and they fell in the unequal and everlasting battle between light and darkness. Many a country had been lit up by the lurid light of the stake. The victims became the living torches of light, centres of that sacred fire at which later generations lit their lamps and kindled the holy flames for the altars of human knowledge, just as they lit the lamp in the temple of Vesta or in the Indian worship at the specially prepared sacred fire.

As a symbol of penitence and punishment the lighted, in some cases the extinguished taper was placed in the hands of the delinquent, and he had to march through the streets holding it in his hands. He was led either to the pyre or to the gaol. A Lord Mayor of London in olden times convicted of crime would also be led with the taper in his hands through the streets of London, and exposed to the taunts and jeers of the citizens. The underlying idea, of course, entirely forgotten in modern times, when that punishment was inflicted was, that the culprit had forfeited the favours of the gods, had extinguished the holy flames, had committed a heinous crime, and was thus bringing down upon himself the vengeance of the outraged powers, or, when he carried the taper to the pyre, he was himself lighting up his self-sacrifice and brought himself as an offering to the offended deity.

In later times a new set of ideas was joined to these older conceptions, and hand in hand with the deeper insight into human nature went the recognition of the difference between spirit and matter. The one representing the grosser elements, easily identified by touch and sight, and the other the impalpable, invisible, and not easily defined or apprehended by human sight or touch. The very essence of the spirit was the absence of any of the attributes of matter, and hence it came to pass that in the desire of giving figurative expression to it, light was taken as being the nearest approach to the essence of life. The symbol used to denote the soul, the illuminating vivifying power in man was the burning torch, the kindled light; whilst death, the disappearance of the soul, was expressed by the extinguished torch. The fire had ceased, and with it the individuality had disappeared. Where light and mind had been, there was now darkness and void. And insensibly, though irresistibly once the mind had been set travelling on this line, the notion of light and darkness, of the lit-up and the extinguished flame, of vitality strengthened or impaired, of the flicker of life gone out after a bright display, the proximity of life and death, led men to contemplate the life beyond the grave, the life hereafter. Other and deeper thoughts about life and immortality, about the fate of the soul after it leaves the body, the love for the departed, and the desire of

granting them some at least of the light which they enjoyed in this world, produced a peculiar state of mind and a peculiar set of ceremonies and practices connected with death.

Again, whilst the abode of the dead was believed to be dark, old myths told of the descent of the gods of light into the nether regions. The gods, who had in one way or another brought the fire from heaven to the earth and gave it to man, had to descend deeper into the bowels of the earth, and there expiate for their temerity either by working in the midst of the roaring flames of the smithy (vulcan) or burning in the midst of fiery streams of Hell. Thus the fire became an instrument of torment.

(*To be continued.*)

The Illuminating Engineering Society.

(FOUNDED IN LONDON, 1909.)

IN referring to the work of the **Illuminating Engineering Society** in this journal, we have always laid stress upon the complexity of the subject of Illumination, and the number of different aspects which have to be studied, and which, too, necessarily vary according to the conditions in different countries. The aim of the Society has been from the first to bring together those who possess specialized knowledge of these different aspects, and the Council have approached a large number of such authorities with the object of enlisting their sympathy and support. The Editor of this journal, during his recent visit to the Continent, had opportunities of meeting many of these authorities personally, and of explaining to them the intentions of the Society, which invariably met with a favourable reception. Many of these gentlemen will be known to our readers as contributors and supporters of *The Illuminating Engineer*, and their knowledge of the standing of this journal was naturally influential in leading them to appreciate the lines on which the movement is designed to proceed.

In order to illustrate the representative and international nature of the support already obtained, we may mention in alphabetical order the names of a few of those who are expressing their sympathy with the movement by becoming Vice-Presidents and Corresponding Members :—

Dr. Louis Bell (Boston, U.S.A.), Dr. F. Blau (Berlin), Dr. L. Bloch (Berlin), Prof. A. Blondel (Paris), Dr. E. Budde (Berlin), Prof. H. Bunte (Karlsruhe), Sir William Crookes (London), M. Sainte Claire Deville (Paris), Prof. H. Drehschmidt (Berlin), Mr. E. L. Elliott (New York), Dr. A. H. Elliott (New York), Prof. J. A. Fleming (London). Mr. W. H. Gartley (Philadelphia),* Herr F. Göhrum (Stuttgart), M. A. Guiselin (Paris), Herr J. Herzog (Budapest) Dr. E. P. Hyde (Ohio, U.S.A.), Dr. H. Krüss (Hamburg), Mr. V. R. Lansingh (New York), Prof. Vivian Lewes (London), Prof. G. Mantica (Milan), Mr. L. B. Marks (New York), Dr. F. Martens (Berlin), Mr. H. Thurston Owens (New York), Sir William Preece (London), Sir Boverton Redwood (London), Prof. S. Rumi (Genoa), Herr K. Satori (Vienna), Dr. E. Schilling (Munich), Dr. Schumann (Munich), Herr M. Scholz (Berlin), Dr. K. Stockhausen (Dresden), Prof. H. Strache (Vienna), Prof. K. Ulbricht (Dresden), Dr. W. Voege (Hamburg), Herr E. W. Weinbeer (Berlin), Sir H. Trueman Wood (London), &c. And we are particularly gratified to be able to announce that **Prof. S. P. Thompson, D.Sc., F.R.S.**, has kindly consented to become the First President of the Society—a decision which is an excellent augury for its status and future prosperity. In addition a very representative Council has now been formed. The Society will therefore enter upon its opening Session, next November, under excellent auspices, and has every reason to hope for a long and prosperous existence. Any one interested in the objects of the Society and desiring to become a Member is invited to apply to **Mr. L. Gaster, Hon. Secretary, 82, Victoria Street, London, S.W.**

* The President, for this year, of the Illuminating Engineering Society in the United States.

The Lighting of the Houses of Parliament and the Palace of Westminster.

By An Engineering Correspondent.

Introduction.

The Palace of Westminster, where the destinies of Great Britain are decided by the debates that are held within its walls, with its recollections and associations of departed centuries, occupies an area of about eight acres, and has four principal aspects. Within this area there are thirteen quadrangles of courts which facilitate the admission of light and air into the hundreds of rooms and residences and offices of which the building is composed.

The history of the illumination of this vast building, and particularly of that restricted to the one hall where the Commons used to sit since the division of Parliament into two houses (1377)* is curiously instructive. The mode of illumination throughout corresponded, in a sense, with the conception of constitutional history, and the illuminants with the style of architecture and the size of the different buildings known as the House of Commons (for instance, the lighting arrangements in the present House of Commons are different from those in the old House—the present House is much higher and the galleries do not project quite as far). The light used was proportional to the dimensions of the room, &c., &c. It may be of interest to mention in connexion with this question that the lighting in the House was for a long time the subject of a fierce controversy, especially in the beginning of last century, arising from the want of a proper understanding between the architect, Sir C. Barry, and Dr. Reid, to whom the superintendence of different parts of the buildings had been confided; but it is now an "ideal one."

In the following lines I will try to give a sketch of the different illuminants, from the wax candle down to the ingenious method of lighting above the ceiling of the House in use to-day, and to weigh their merits from the *historical*, *artistic*, and last, but not least, *practical* standpoint.

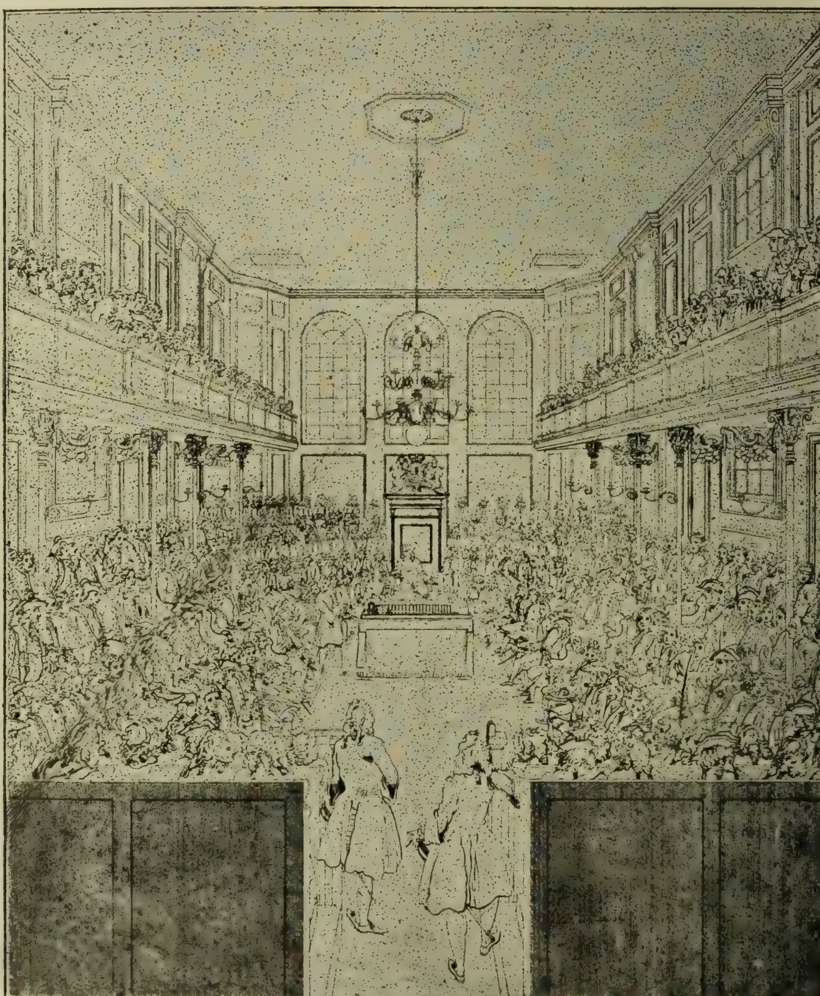
The present national building, this mediæval palace where the very spirit of antiquity seems to hover over the walls and buttresses, the diapered glass and the square-headed windows divided by the mullions, tells us of the early days when patriots wrung our liberties from the grasp of king and pope alike. But the illuminant which is in harmony with such stained windows, gilded angels, pillars and pedestals, has been banished. The wax candles of the old House's candelabra, those "furnaces" (as somebody called them), the heat radiated from which pervaded every part of the House and often rendered it intolerable, are replaced by modern inventions; but it might be added that the replacement of the old candelabra by modern gas-jets and electrical fittings is perhaps the most successful attempt which has yet been carried out in mediæval buildings.

The new mode of lighting through the panels of the ceiling with its pleasing soft mellow radiance is in harmony with the traditions of our old national palace, and still speaks to us the language of Simon de Leicester of De Montfort, of England under the first and greatest Edward.

For the better understanding of the details to be supplied in a subsequent

* For close on one century the three estates of the realm, the Prelates, the Nobles, and the Commons, deliberated together as *one* Council. The Commons having elected Sir William Hungerford as their first Speaker, assembled in the Chapter House of Westminster Abbey. Their next place of meeting was Westminster Hall, and finally St. Stephen's Chapel, assigned by Edward III. in 1550.

contribution I should like to mention here the fact that the Halls where Parliament formerly sat varied on different occasions. For instance, the original council-chamber in the Old Palace of Westminster, the room which in later times served for the meetings of the Commons, was originally a spacious chapel of King Stephen, by whom it was dedicated to the saint of his own name and rebuilt by Edward III. (*vide* Patent Roll of 22 Edward 'De fundatione capella S. Stepheni in palatiæ Westmonasteri'). *Westminster Hall*, on the other hand, where Parliament often sat, is quite different as regards size, shape, and style. We may form an idea of its size and the number of candles requisite to illuminate this building when we are told that Richard II. in 1399 kept his Christmas in it "in the midst of 10,000 guests." And, leaving out of consideration St. Stephen's Chapel, a comparison of the methods of illumination employed in ancient times can hardly be made



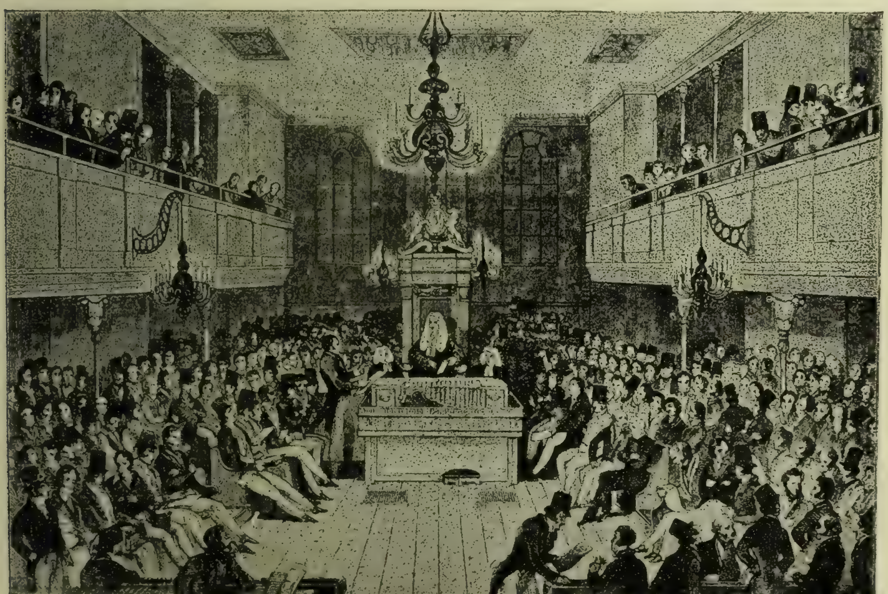
Macbeth.

FIG. 1.—House of Commons as it appeared in 1741.
(Smith, 'The Antiquities of London,' 1807.)

when we take into consideration the varying size of the present chamber at different periods. In 1706 two side-galleries were added by Sir Christopher Wren, shortly after the union with Scotland, and in 1800 the chamber underwent a final transformation, when, as a result of the union with Ireland, seats for one hundred additional members had to be found.

But through all these changes the old relics—the candles, "those types of the elements whose glorious strife formed this free England and still guards her life"—remained. And when in the early days of the nineteenth century Dr. D. B. Reid suggested the introduction of gas light, the categorical answer he received from Sir Benjamin Stephenson and the Earl of Bessborough was: "Do what you will for the acoustics and ventilation, but take it as a fixed and settled point that wax candles remain!"

But despite this veto, the doom of the wax-candle was fast approaching. Oil lamps were already used in the libraries, division-rooms, passages, and lobbies, and later on the Bude light (which was an Argand oil lamp through the flame of which a stream of oxygen gas passed) was adapted to the purposes of lighting the House. The system of gas illumination adopted by Sir C. Barry (viz., by large gas chandeliers descending for a considerable distance into the body of the House) was in complete accordance with the general architectural character of the room. But it rendered the requisite control over the ventilation difficult, if not impossible, and in consequence of defective arrangements in regard to the gas, much of it escaped from the pipes and burners and contaminated the air in the House. The difference of temperature, too, was so great that a member sitting in the gallery would have his feet in a temperature of about $68\frac{1}{4}°$, the centre of his person at 70°, and a very little above his head it would be about 73°.



Macbeth.

FIG. 2.—Interior of the House of Commons in 1834.
(Thornbury, 'Old and New London,' vol. iii., p. 511.)

The raising of the chandeliers was a great improvement; but there was still the trouble that it fell directly on the eyes of persons sitting in the

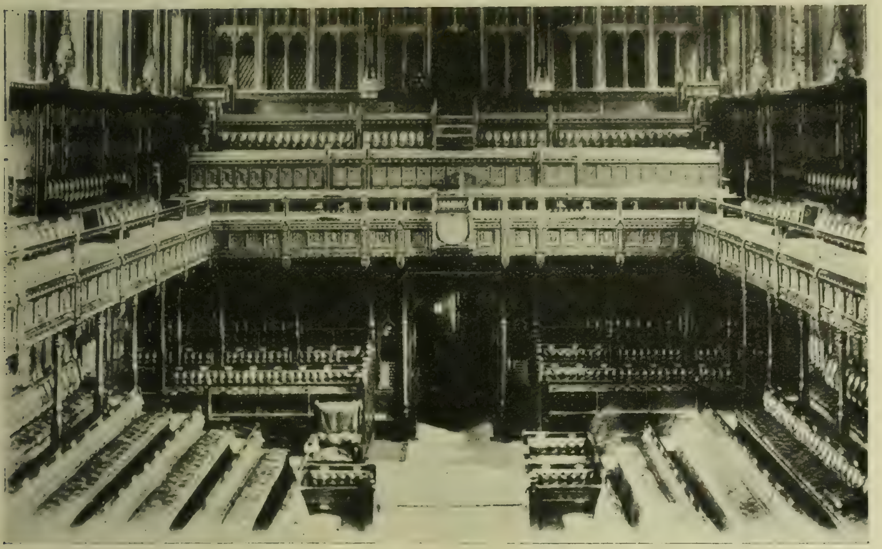
gallery. At last Mr. Gurney succeeded in his method of lighting by insulating the lamps from the body of the House, so that the warming and ventilating of the House were not interfered with. The artistic skill of the carvers of the original lofty oaken roof was sacrificed and the old ceiling replaced by a new one which answers purposes of ventilation as well as the lighting of the House. The ceiling is of glass of a yellow colour and is divided by richly carved oaken ribs into as many as forty-eight panels, on the outer side of which the gas lights are arranged. The adoption of this mode of lighting was also due to other considerations; *e.g.*, the heat produced by the combustion of so large a quantity of gas as would be required to transmit sufficient light through the ground-glass panels, and the effect of the heat on the House by radiation downwards from the roof, and last, but not least, the ventilating arrangements.

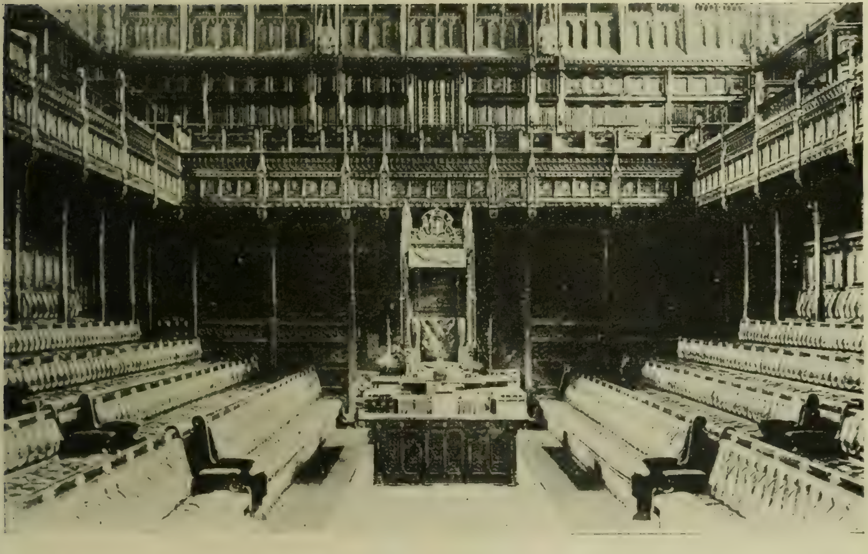
All these conditions seem to be met, especially the question of ventilation. A hundred years ago the only means of ventilating the chamber were by four openings, each one foot square, made in the ceiling of the House, by order of Sir Christopher Wren; short tubes were placed by him over these openings to make them draw more strongly, and fires were lighted below them so as to increase the effect. Another adviser by-and-by introduced a revolving fan over the ceiling of the House, which, although answering better than the preceding arrangement, was still very inadequate. Then about 1822 Sir Humphrey Davy being consulted, caused two iron tubes of one foot diameter to be inserted in the ceiling and to serve as channels for the expulsion of the vitiated air. These tubes, in their upward course, also passed through fires, so as to increase the draught.

Not long after this occurred the destruction of the Houses by fire. In the temporary House which succeeded Dr. Reid introduced for the first time an adequate means of removing the foul air, which in principle exists to this very day, and which will be dealt with later. I have, however, especially commented upon the question of ventilation, because it was, and is, entirely connected with the prevalent mode of lighting.

I have pointed out above that the old House cannot be directly compared with the new one as to lighting purposes, on account of its size. I may add that the entire length of the old House of Commons and the lobby together was about half that of the present hall; their breadth was also about half the present dimensions, their entire area being, therefore, only a fourth of the area of the new building; and of this space the lobby occupied considerably more than a third, having, therefore, the length of the House of Commons not quite equal to the breadth of the present Westminster Hall. But the windows in the House are, and were, of stained glass, displaying the rose, thistle, and shamrock. The daylight illumination thus provided and the conditions to which it gives rise resemble those in the old House, though, as we have seen, the artificial illumination is very different. Great credit is due to the judgment of those who have prudently retained the original time-honoured candelabra, and have ingeniously adapted them to meet the requirements of modern electric lighting. These handsome candelabra, which are in complete harmony with their architectural surroundings, serve their present purpose most effectually. I should also like to take this opportunity of offering my very sincere thanks to Mr. Erskine, the Serjeant-at-Arms; Mr. Rivers, the Officer of Works; Mr. Bradshaw, the Resident Engineer, and Mr. Bowden for their great kindness in allowing me to examine the various methods employed for illumination and ventilation, which I hope to lay more fully before my readers in a subsequent article.

As I am reserving all details with regard to lighting for a subsequent contribution, I will only add a few figures as to the cost of the different modes of illuminating employed at various stages in the House, which however, for the reasons stated above, are not strictly comparable. In 1838, when candles were generally used, the





FIGS. 3 & 4.—THE PRESENT HOUSE OF COMMONS; ENTRANCE VIEW AND SPEAKER'S CHAIR.

(The illumination is now secured solely by the aid of lamps above an artificial diffusing glass roof.)

cost was £996 13*s.* 10*d.*; in 1865/66, when the chief illuminant was gas, the cost was £3,505. Last year the amount spent upon electric lighting was £4,712 17*s.* 7*d.*, and upon gas lighting £2,904 17*s.* 7*d.*; in addition £400 18*s.* was paid for external lighting by gas. A spirit of economy regarding this matter prevailed, and still prevails, in the House. It manifested itself in the controversy of 1889* that raged around the oil lamps supplied to the House of Commons at that time, and which figured in the estimates for no less a sum than £2,000. Since then oil lamps have been replaced by the electric light, which is now introduced in nearly all parts of the House—even as side-lamps in the Chamber.

DR. B. S.

(*To be continued.*)

* *Vide* Parliam. Reports of April 8th, 1889.

The Gradual Intrusion of New Illuminants in Old Surroundings.

ANOTHER interesting instance of the appetite of the general public for information relating to illumination is provided by *The Evening News* (Friday, September 24th), which devotes a portion of 'To-day's Gossip' to some interesting remarks on the gradual intrusion everywhere of up-to-date methods of illumination.

There are many ancient and stately houses in this country, it is pointed out, where candles constituted the only admissible illuminant, long after electric and gas lighting came into general use.

One of the most recent instances of conversion is Caen Wood House, the residence of the Earls of Mansfield, which until two years ago was lighted exclusively by candles.

"Thus," our contemporary remarks, "the wax candle which had already retreated to such stately houses as Caen Wood is yielding its last strongholds. There was much to be said for the wax candle which served us well for many a hundred years, and which will now keep its places only upon altars. . . . A beautiful white shaft, it burned in a candlestick which was often a craftsman's best work. . . . The one fault of the candle was its feeble light. The Lord Mansfields and their like might sit in a glow of candle-beams, but smaller folk passed their winter evenings in an eye-racking twilight. Also let us remember that the wax candle was costly. There are those living who can recall the early Victorian inn's bill, which, for 'a gentleman who called himself a gentleman,' began with the item of 'wax lights—5*s.*' And the wax candle had its poor relations, the tallow dips, whose savour is not easily forgotten."

The age is hurrying by, and the children of to-day have already learnt to look upon gas, electric, acetylene, petrol-air, and other methods of illumination, as commonplace conveniences, and to regard the old tallow candle as a curiosity. "To a twentieth-century babe, the miracle of the electric button is the normal and unremarkable method of producing light, while the candle is a mild tempered firework, a festal device for lighting birthday cakes."

Light as a Means of Attracting Attention.

IN this journal attention has frequently been drawn to the part played by the suitable illumination of a sign or notice in order to make it stand out from its surroundings.

A recent cartoon in *Punch* humorously emphasizes the same point. The attendant in one of the tube-lifts remonstrates with a passenger who is smoking furiously in defiance of the small forbidding notice above his head. In extenuation he points to the vastly more prominent notice on the side of the lift advising him "To smoke P.P.C.," and this, he points out, "is just what I am doing." A striking comment on the frequent difficulty of distinguishing officia notices from the advertisements surrounding them.

A Comparison between the Illuminating Efficiencies of Carbon Monoxide and Hydrogen when used in conjunction with the Incandescent Mantle.

By Arthur Forshaw, M.Sc., Institution Research Fellow in the Department of Fuel and Gas Engineering, University of Leeds.

(Paper read at the Annual Meeting of the Institution of Gas Engineers, London, June 15, 1909; we are indebted to the courtesy of the Council of the Society for permission to publish this paper and to the *Gas World* for the loan of the blocks by which it is accompanied.)

(*Continued from p.* 542.)

D. *Results of Experiments.* Before proceeding to the results of experiments, it is necessary to make several definitions and explanations of terms used in the tabulated results.

H_2 = cubic feet of hydrogen per hour measured at 0°C. and 760 mm.

CO = cubic feet carbon monoxide per hour measured at 0°C. and 760 mm.

Air = cubic feet per hour measured at 0°C. and 760 mm.

C.P. = candle power in sperm candles.

$\frac{\text{C.P.}}{\text{Gas}}$ = candles per cubic foot of gas per hour = duty.

$\frac{\text{Air}}{\text{Gas}}$ = cubic feet of air per cubic foot of gas.

$\frac{\text{CV} \times \text{Gas}}{\text{C.P.}}$ = colories per candle per hour.

All gas measurements are reduced to dry gas at 0°C. and 760 mm.

The first experiments were made with hydrogen, using a No. 2 mantle. It was soon found, however, that the burner-head, as originally designed, was not suitable to the combustion of a mixture of hydrogen with more than about one-fifth of the air necessary for complete combustion. As soon as the ratio of air to gas in the mixture issuing at the burner-head reached the limit of 0·52, back firing occurred. The approach of this limit was always heralded by a peculiar singing noise in the burner-head, and in these conditions the addition of even a small amount of air caused the mixture to explode down the tube of the burner with considerable violence. Within the narrow limits of variation of the proportion of air to gas imposed by the construction of the burner, it was found :—

1. That the duty obtained with each particular rate of consumption of hydrogen increased with the amount of admixed air up to the point at which back firing occurred.
2. That the duty obtainable regularly decreased with the rate of hydrogen consumption.

This is clearly shown in Table I., as follows :—

TABLE I.

H_2	$\frac{\text{C.P.}}{H_2}$ No Air.	$\frac{\text{C.P.}}{H_2.}$ Moist Air.	$\frac{\text{Air.}}{H_2}$
2·35	6·8	7·9	·52
2·87	5·64	7·02	·48
3·32	4·87	6·32	·45
3·62	4·72	6·19	·43
3·95	4·0	5·39	·39
4·80	—	4·94	·35
4·99	—	5·04	·26
5·13	2·91	4·5	·43
5·65	—	3·77	·37

* As far as the author is aware diagrams have not before been used for this purpose. As indicators of the distribution of illumination over the mantle surface, they may be compared to the "indicator diagrams" which show the distribution of power over the stroke in an engine cylinder.

In further experiments on hydrogen with this burner, it was found that the best duty was obtained when the ascension pipe was fixed as high as possible above the nipple—due, no doubt, to better admixing of the gas

and air before it reached the burner-head. It was also remarked that whereas with low consumptions the mantle was brilliantly illuminated at its base but rather poorly on the higher portions of its surface, with high rates of consumption the illumination of the base fell off considerably, whilst that of the middle and upper portions was greatly increased. This circumstance is doubtless to be ascribed to the squat and bulky shape of a badly aërated hydrogen flame, which is ill adapted to any ordinary form or size of mantle. It was therefore decided to modify the construction of the head of the burner in order to allow of a much better aëration of the hydrogen flame without its striking back. This entailed several months' experimental work.

At this stage of the investigation, it was becoming increasingly evident that the distribution of illumination over the surface of a mantle was vastly different in the case of the two gases when burnt under similar conditions with a badly-aërated flame. Arrangements were therefore made to compare the distribution of illumination over the mantle in the two cases. The method adopted was to estimate the intensity of the illumination of small areas over the whole of the mantle by means of a Féry optical pyrometer, which gives what is essentially a photometric measure of the luminous radiation in terms of an arbitrary temperature scale attached to the instrument.

With regard to the experiments under consideration, the illuminations of the various parts of the mantle are expressed in terms of the readings on the arbitrary temperature scale of the instrument, but it must be understood that these temperatures would only be approximately correct if a mantle corresponded to the ideal "black" body. For the purpose of this paper, their readings may be taken as relative measures of illumination according to a particularly arbitrary scale, and the various diagrams relating to these experiments must be interpreted accordingly. In carrying out the tests, portions of the mantle were screened off from the pyrometer by means of a sheet of metal having a rectangular hole 12·5 mm. wide by 5 mm. high. The screen was placed about 2 in. in front of the mantle, and the optical pyrometer was fixed at a distance of about 6 ft. on the other side of the screen in correct alignment with the slit. The burner carrying the mantle was mounted on a carriage provided with a rack-and-pinion arrangement, whereby successive areas of the mantle could be brought opposite the slit and the distribution of illumination over the whole surface of the mantle from top to bottom could be mapped out. The character of results obtained is shown in the curves in Diagrams 1 and 1A.

In these diagrams the vertical heights above the burner head of the centre of the small areas examined on the mantle surface are plotted as ordinates against readings on the arbitrary scale of illumination as abscissae.*

The actual figures for consumption of gas and air for these curves are shown in Tables II. and IIA., and were obtained with the small No. 0 size mantle.

TABLE II.

Curve.	Gas.	Air.	C.P.	C.P./Gas	Air./Gas.
a	1·88 CO	*Nil*	9·48	5·03	. .
b	1·88 CO	0·66	15·15	8·04	·35
c	1·86 H_2	*Nil*	3·77	2·03	. .
d	1·86 H_2	0·74	5·18	2·78	·40

TABLE IIA.

Curve.	Gas.	Air.	C.P.	C.P./Gas.	Air./Gas.
a	1·22 CO	*Nil*	10·75	8·79	. .
b	1·22 CO	0·52	7·45	6·09	·42
c	1·30 H_2	*Nil*	2·9	2·23	. .
d	1·30 H_2	0·56	3·94	3·03	·43

The figures in the above tables refer to similar rates of consumption of hydrogen and carbon monoxide, for the same mantle and burner, with flames almost equally aërated. The total

* As far as the author is aware diagrams have not before been used for this purpose. As indicators of the distribution of illumination over the mantle surface, they may be compared to the "indicator diagrams" which show the distribution of power over the stroke in an engine cylinder.

light afforded is, however, very different in the two gases, nor is the reason far to seek. A glance at the curves shows that the distribution of illumination is quite different; for whereas the illumination caused by hydrogen is mainly at the bottom of the mantle and falls away very rapidly on the upper half, owing to the squat and bulky shape of the flame, in the case of carbon monoxide the illumination is very little different on the upper and lower halves of the mantle, the falling off being quite gradual, and pointing to an upright tapering flame for this gas.

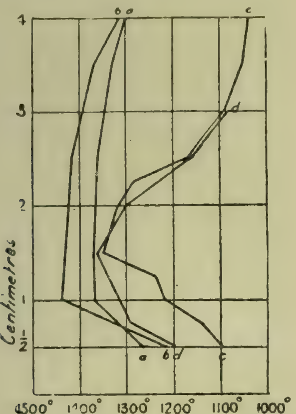


Diagram I.
Comparison of illumination CO (a, b) and H_2 (c, d) for same amounts burning.

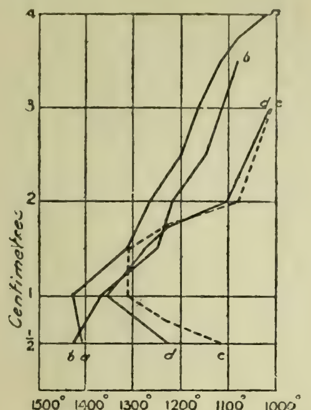


Diagram Ia.
Typical curves of illumination for CO (a, b) and H_2 (c, d).

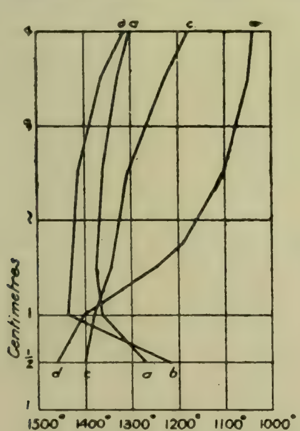


Diagram II.
(a) Too little air.
(b) Correct amount of air.
(c) Too much air.
(d) High excess of air.

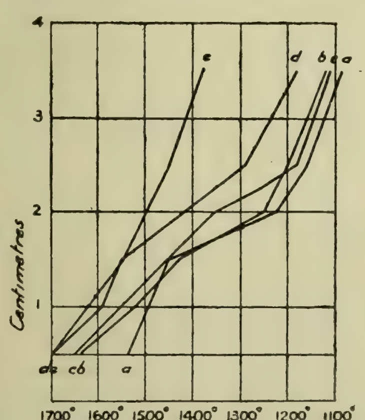


Diagram III.
(a) Too little air.
(b) Too much air.
(c) Correct amount of air.
(d) Effect of more gas and air on b.
(e) Effect of more gas and air on d.

With the addition of a small amount of air to the hydrogen flame, the illumination of the bottom of the mantle was immediately increased, while that of the upper portions faded. The flame is smaller and more concentrated. This is shown in Diagram 1, curves c and d, and in Diagram 1a, curves c

and *d*. In the case of the carbon monoxide flame, the addition of air increased the illumination all over the mantle surface (curves *a* and *b*, Diagram 1 and 1A). As the result of increased aëration, the flame shrank and fitted the mantle better. Evidently this was the best possible fit with this rate of consumption of carbon monoxide; for on adding more air the candle-power dropped and the illumination of the upper half of the mantle became less and less. This is shown graphically in Diagram II. Here, in curves *c* and *d*, the bottom of the mantle only is appreciably illuminated, the illumination of the top falling away in a very marked degree. The rates of consumption corresponding to these curves are shown in Table III.

TABLE III.

Curve.	CO.	Air.	C.P.	$\frac{C.P.}{CO.}$	$\frac{Air.}{CO.}$
a	1·88	—	9·48	5·03	—
b	1·88	0·66	15·15	8·04	·35
c	1·88	0·94	14·7	7·80	·50
d	1·88	1·69	7·87	4·18	·90

It may be noted here that with these low rates of consumption the burner was not working at its best, and, consequently, the values for the duties are low as compared with those shown in the next table.

TABLE IV.

Curve.	CO.	Air.	C.P.	$\frac{C.P.}{CO.}$	$\frac{Air.}{CO.}$
a	2·05	2·37	18·47	9·01	1·16
c	2·05	3·19	23·75	11·64	1·56
b	2·05	3·91	20·15	9·83	1·91
d	2·59	3·78	36·6	14·10	1·46
—	2·59	4·05	40·5	15·61	1·56
e	3·09	5·00	60·0	19·41	1·62
—	3·09	6·18	43·8	14·17	2·0

The illumination curves for this table are shown in Diagram III.

Curves *a*, *c*, and *b* in Diagram III. are interesting, as showing the greater illumination obtained on increasing the aëration up to a certain limit, and its subsequent falling off when too much air was added. Starting with too little air, curve *a* shows a considerably lower illumination both at the bottom and top of the mantle than curves *c* and *b*. The addition of a little air evidently caused the flame to shrink and fit the mantle better. At this consumption of carbon monoxide, this degree of aëration gave the best duty (curve *c*). The addition of more air apparently brought the flame inside the mantle, and there is a general lowering of the illumination over most of the surface, curve *b*. At this point the consumption of carbon monoxide was increased, the flame became larger again, and curve *d* was obtained. Here the illumination was better all over the mantle. The ratio of air to gas was now lower than that for the last maximum duty. Therefore, on increasing the air again, the candle power rose in accordance with expectation. The illumination curve for this experiment was not determined. On further increasing the consumption of gas and air, the illumination of the upper half of the mantle, which in curve *d* is not so good as that of the lower half, was increased, and curve *e* was obtained. The ratio of air to gas for curve *e* is higher than that for curve *d*. A further increase of added air lowers the duty as shown in the table. The illumination curve for this experiment was also not determined. The results in Tables III. and IV. are in entire accordance with M. St.-Claire Deville's conclusion that the ratio of air to gas required for the maximum duty increases with the actual consumption of the gas.

(*To be continued.*)

Acetylene Lighting in Turkey.

A RECENT number of *Acetylene* draws attention to the possibilities of the development of acetylene lighting in Turkey. Until quite recently it was forbidden to introduce calcium carbide into the Ottoman Empire, but the law has recently been repealed, and it is now thought that the modernizing tendency in Turkey should enable acetylene to make a footing.

Simple Methods in Illuminating Engineering.

By Alfred A. Wohlauer.

The usefulness of the "Fluxolite paper" as a tool of the designing illuminating engineer is proved by its numerous applications, and by the simplification it introduces into the calculation and design of illumination. This point was referred to in the April issue of the New York *Illuminating Engineer*, and is further illustrated in the following note, which deals with the solution of a few problems which hitherto could hardly be handled in a systematic engineering manner on account of the tedious mathematical manipulations involved.

The first example refers to the design of a reflector for street lighting. A 100 watt tungsten lamp, the light-distribution of which is indicated in Fig. 1, is to be provided wite such a reflector that as large a ground-area as possible is illuminated with a uniform illumination of about 5 lux (approx. 0·5 foot-candles) 2 ft. above the ground. The height of the centre of the light source is assumed to be 12 ft. above the ground, or 10 ft. above the plane to be illuminated; the light absorption due to the reflector, &c., is supposed to be not greater than 40 per cent.

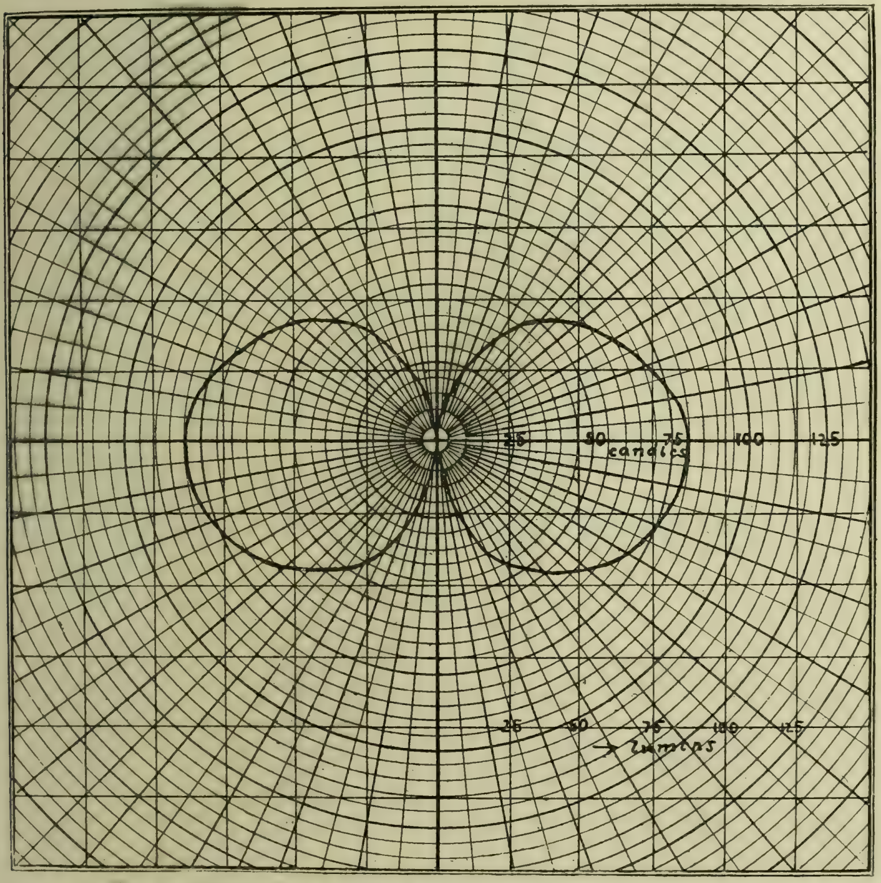


Fig. 1.—Distribution of light from 100 watt Tungsten lamp (clear).

From Fig. 1 we easily can read off the flux distribution corresponding to the original light distribution of the 100-watt tungsten lamp. These values are entered into the second column of Table I.; their sum equals 804 lumens, and gives the total flux of the 100-watt tungsten lamp.

Considering a loss of 40 per cent, which is probably higher than the actual value, a flux of at least 480 lumens can be utilized on the plane under consideration. This enables an area whose diameter is about 34 ft. to be uniformly illuminated with an illumination of 5 lux, if 480 lumens are at our disposal.

The curve of light distribution which provides for a uniform illumination is indicated in Fig. 2. The reflector has to be designed in such a way that it transforms the original distribution of Fig. 1 into the one of Fig. 2. The flux distribution to be realized can easily be read off Fig. 2, and its values are entered into the third column of Table I.

The Fluxolite paper has performed its duty for this work, and all that remains to be done is to transfer the original flux distribution of column 2 into column 3. (This work of actually designing the reflector, though very interesting, can only be briefly dwelt upon at present; it merely consists of a graphic operation to be performed on the drawing board.)

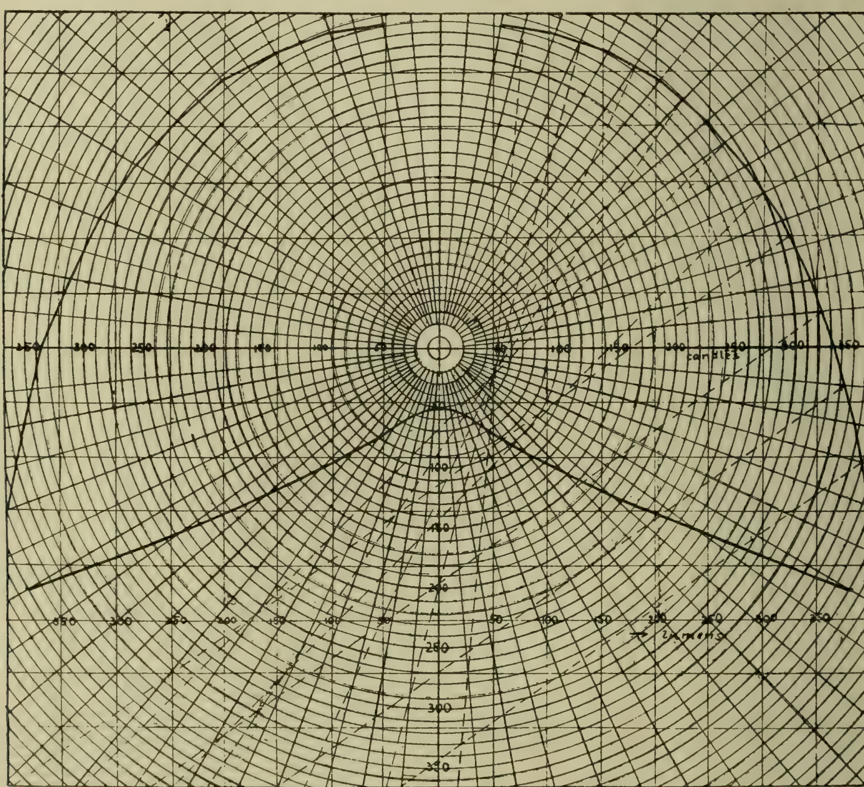


FIG. 2.—Street-lighting reflector for uniform illumination.

According to columns 2 und 3 the original flux between 0 and 60° is not sufficient to procure the required light distribution. An additional flux, as indicated in column 4, has to be deflected into this direction, for which the flux between 60° and 180° is at our disposal. Of course, only a certain percentage thereof (60 per cent) can be utilized on account of light-absorption, &c., there being thus at our dis-

posal the actual flux as indicated in column 5. Comparing columns 4 and 5 one finds that the flux of 26 lumens, at our disposal between 130° and 140°, is just equal to the flux required in the direction between 30° and 40°. If the reflector, therefore, is designed in such a way that it reflects the flux between 130° and 140° in the direction of between 30° and 40°, the required quantity of light will be obtained in the latter direction. Similarly the flux between 110° and 130° should be reflected in the direction between 40° and 50°, while the flux between 70° and 110° ought to be deflected in the direction between 50° and 60°, &c., as indicated in column 6 of Table I.

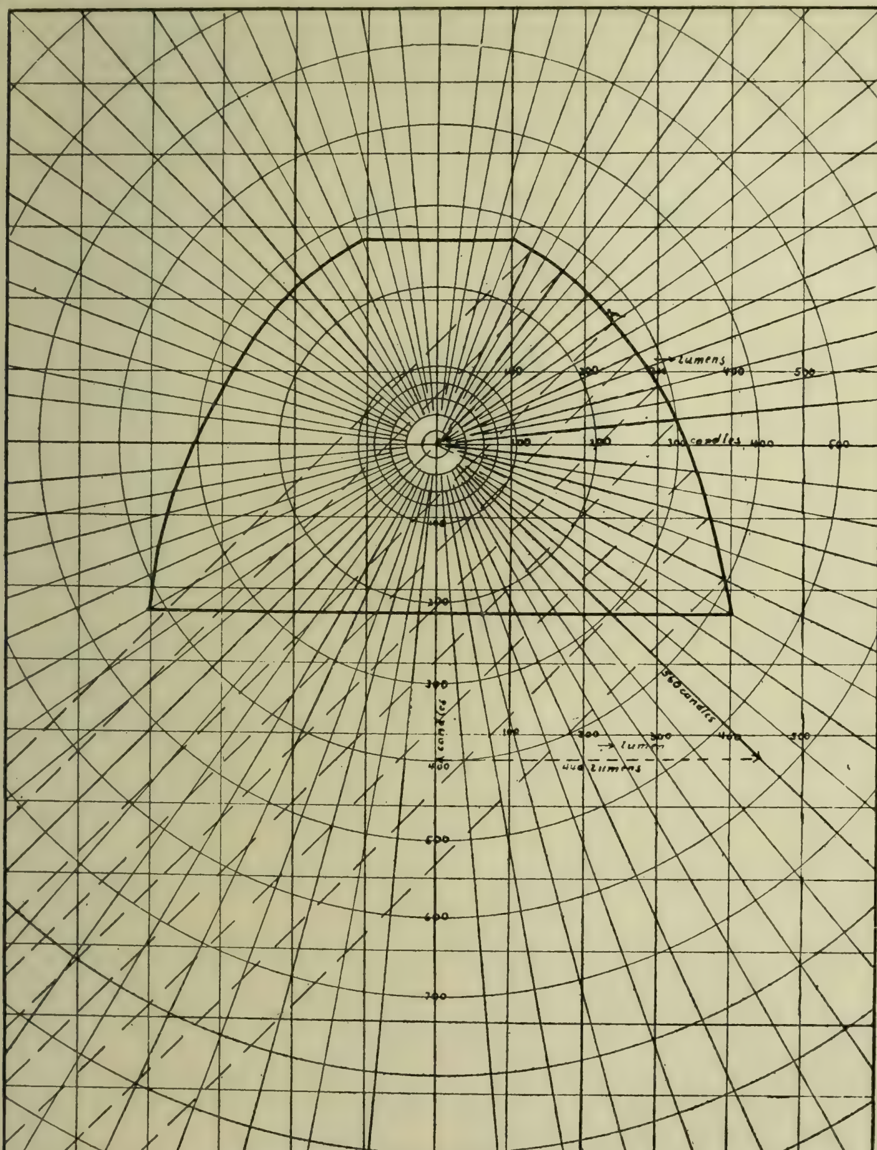


Fig. 3.—Reflector for 10 feet library table.

There are various possible methods of determining the actual shape of a

reflector, one of which is represented in Fig. 2.

A second example refers to the illumination of a round table 10 ft. in diameter, such as might be used in large libraries, dining-rooms, and the like. In this case it is not necessary to illuminate uniformly the total area of the table. It will be sufficient to illuminate in a uniform manner a ring of about 18 in. width around the edge. The problem is to determine the illumination which can be obtained on this angular plane if a single 100-watt tungsten lamp is used in the most efficient manner for the purpose. Using a height of suspension of 4 ft. above the table we see at once that as much light as possible must be concentrated at an angle between 40° and 50°. It is also evident that the light between 0° and 40° cannot be conveniently utilized for this purpose, and must be left for the general illumination at the centre of the table; practically all the other light, however, is at our disposal for the illumination of this annular space.

After this long explanation the solution of the problem by the use of the Fluxolite paper appears very simple.

From Fig. 1 it appears that a flux of 60 lumens is contained between the angles 0° and 40°, 804 lumens being the total flux of the 100-watt tungsten lamp; 744 lumens are therefore at our disposal for this purpose. Assuming again a loss of 40 per cent, a flux of 446 lumens can actually be utilized. Entering this value on a Fluxolite sheet (Fig. 3), it is a very simple matter to read off the length of the 45° light vector which corresponds with this flux. In our particular case it is 560 candles.

These simple manipulations show what a considerable candle-power is at disposal for the illumination of the region of the table desired even on the assumption of a loss of light of 40 per cent. The illumination obtained will amount to 12 foot-candles, which is much more than is actually required. Such values are by no means unobtainable, and there is nothing to prevent their realization in practice if proper attention is paid to the design of reflectors.

The two examples alone will perhaps serve to show how these processes, with which in all probability the illuminating engineer will continue to have much to do in the future, are simplified by the use of the Fluxolite paper.

TABLE I.

DESIGN OF STREET LIGHTING REFLECTOR.

	Flux without Reflector	Flux required	Additional flux required	Flux at disposal	To be reflected
0–10	2	5	3		
10–20	8	16	8		
20–30	18	26	8		
30–40	32	58	26		
40–50	47	110	63		
50–60	60	240	180		
60–70	73			44	
70–80	83			50	
80–90	81			52	50 to 60°
90–100	87			52	
100–110	79			47	
110–120	68			41	40 to 50°
120–130	51			34	
130–140	43			26	30 to 40°
140–150	29			17	
150–160	15			9	0 to 30°
160–170	5			3	
170–180	1				

Public Lighting.

[Report of the Deputation appointed by the Streets Committee of the Corporation of London to study the lighting of continental cities.]

(*Concluded from p.* 626.)

Brussels.

In the suburbs various contractors undertake the work, the principal districts being lighted by the Imperial Continental Gas Association.

The main thoroughfares, squares, and markets are lit by means of electric arc lamps with an ordinary incandescent gas burner on either side. The arc lamps are turned off at midnight, after which time the lighting is supplied by gas. The side streets are illuminated by incandescent gas burners.

The total number of electric arc lamps in Brussels is 238, supplied by direct current, consuming energy at the rate of 440 watts, and fixed upon columns. The distance (not diagonal) between the open lamps is 98 to 115 ft., the average height of the lamps being about 20 ft. The width of the streets in which open lamps are used varies from 82 to 98 ft.

The cost per lamp per annum (half night only) including interest, depreciation, and all other charges is £14 9*s*. 7*d*.

There are only two centrally suspended electric arc lamps, and these are fixed in the "Grand Place," from the Hotel de Ville across the Market Place (the lamps taking 1,100 watts each), at an altitude of about 70 ft.—the width of the Market Place being about 200 ft.; the lowering gear in connexion with the lamps is placed within the Hotel de Ville.

No accidents have been reported to have occurred from this method of attachment.

Electric glow lamps are not used in the public streets of Brussels.

Incandescent gas lighting is largely used in the City, the lamps generally being fixed upon standards, but brackets are used in the smaller streets. The type of lamp most prevalent is a conic lamp with two upright burners, also inverted burners in groups of three or five. These lamps consume from 3½ to 8½ cubic feet of gas per hour, according to the burner, the illuminating power obtained by the upright burners being equal to 55 candles, and of the inverted burners 133 candle-power.

The height of lamps above the roadway, measured from the burner, is from 11½ to 14¾ ft.

There are no public high-pressure incandescent gas lamps in Brussels.

The Deputation was informed that the lighting of the City, both by gas and electricity, is carried out by the Municipal authorities without the intervention of a contractor.

Paris.

The general arrangement for lighting the streets is much the same as in London, electric lamps upon columns being generally used.

The total number of electric arc lamps in Paris is 1,899, of which 559 are supplied by alternating current, and 1,340 by direct current. The lamps are fixed about 100 feet apart at about 14 feet to 18 feet high, the main streets of Paris being 70 feet to 100 feet wide. A large number of these lamps are extinguished at 1 o'clock a.m.

Electric glow lamps are not used in the public streets of Paris.

The types of incandescent gas lamps (low-pressure) principally used are: Bandsept, Denazrouze, La Couronne, Kern, Honderele, and Tricquet, &c., the 3 feet per hour lamp giving a light of about 66½ candles, and the lamps are fixed about 80 feet apart on columns on the sides of the streets.

In the "Rue de la Paix," which is about 73½ feet wide, standards with three lanterns fitted with incandescent gas burners (two of these lanterns being extinguished at midnight) are used; the columns are directly opposite one another, the distance between them being about 39 feet, the central one being about 11 feet 11 inches above the ground, the two side ones 11 feet 7 inches. The burners consume 8 cubic feet per hour.

There is not any high-pressure gas lighting in Paris.

Electricity and gas are supplied by Companies under arrangements with the Municipal authorities.

APPENDIX.

City of London.

The total number of electric arc lamps in the City of London is 450. 380 open arc lamps and 20 flame lamps are fixed upon columns and brackets; the average distance between the open lamps is 126 ft., the average height of the lamps being about 18½ ft.

The cost of each of the open lamps is £26 per annum, and of each flame lamp £17 10*s.*

In accordance with the Resolution of the Court of Common Council of July 25th, 1907, permitting the two electric lighting companies having statutory powers in the City to experiment with the newest form of electric lamps for street lighting in the thoroughfares of Holborn, Holborn Viaduct, Old Bailey (part of), the lamps being placed about 20 ft. from the ground, Cannon Street (between St. Paul's Churchyard and Dowgate Hill) at a height of 28 ft., and Farringdon Street at a height of 14 ft., the Charing Cross and Strand Electricity Supply Company proceeded with the lighting of their portion, viz., Cannon Street, by erecting 11 "Oliver" magazine flame arc lamps, centrally hung, and suspended over the roadway by wires attached to the buildings on either side. The lamps were put into lighting in November, 1907, and £17 10*s.* per lamp is the price paid for the experimental running. This is the price quoted by the Company for a contract for not less than 250 of such lamps.

The City of London Electric Lighting Company also proceeded with the carrying out of their experiment by substituting 21 "Oliver" flame arcs for a similar number of the original "open" arcs, adapting the existing standards in Holborn, Holborn Viaduct, and part of Old Bailey, whilst in Farringdon Street 18 enclosed arcs of the "Reason" type were fitted up on special short columns in lieu of the 12 original "open" arc lamps and columns in that thoroughfare. The installation of this area was completed in November, 1907.

The cost of the "Oliver" flame arcs in the Holborn area is £17 10*s.* each per annum, being equivalent to the charge for similar lamps in Cannon Street. The cost of the enclosed arcs in Farringdon Street is £12 10*s.* each per annum.

The "Oliver" flame arc lamps at Ludgate Circus and Ludgate Hill, put into lighting this year, are fixed at a height of 18·5 ft. above the roadway, as against 20·5 with the experimental lamps of the same type at Holborn.

High-Pressure Incandescent Gas Lighting.

There are 119 high-pressure Keith gas lamps in the City thoroughfares, 42 upright single-burner lamps being fixed in the neighbourhood of Billingsgate on brackets. These lamps consume 10 cubic feet of gas per hour, and give an illuminating value of 300 candles each, at a cost of £7 5*s.* per lamp. They are from 60 ft. to 70 ft. apart on the diagonal, the height of burner from roadway being about 12 ft. They are fixed upon the house fronts, the roadway being about 50 ft. to 60 ft. wide. The lamps burn at 10 in. pressure from a special water-compressing plant placed in the adjacent pipe subway. The Corporation provided the compressing plant, services, lamp brackets, and lanterns.

Forty-five upright two-burner lamps are fixed in Queen Victoria Street, each consuming about 20 cubic feet of gas per hour, and giving a light equal to 600 candles, the annual cost per lamp being about £13 2*s.* 3*d.* per annum. The lamps are fixed upon

columns on the footpaths, about 100 ft. apart on the diagonal. The burners are 13 ft. 6 in. above the roadway, the street being about 70 ft. wide. The lamps burn at 10 in. pressure from a high-pressure trunk main direct from the gasworks, the Corporation providing the standards and lamps.

Seventeen high-pressure single-burner lamps (inverted mantles) have been fixed in Fleet Street and Chancery Lane upon brackets on the house fronts. These lamps each consume 25 cubic feet of gas per hour, and give a light of 1,500 candles, at an inclusive charge of £16 10*s*. per annum. They are supplied from a special 6 in. high-pressure main connected with a compressor house in the immediate neighbourhood, the pressure being 54 in. (water-gauge). These lamps are about 103 ft. apart on the diagonal, the height of the burners from the roadway being 13 ft. to 16 ft., the street being from 45 ft. to 70 ft. wide, the Gas Company providing the necessary compressing plant, mains, services, brackets, and lanterns.

There are also several other "Keith" and "Sugg's" high-pressure lamps, fitted with upright 2, 3, 4, and 6 burners, on rests at the junction of roadways, of 1,000, 1,300, 2,000 and 3,000 candles, making 119 in all. In addition to the above the four City bridges are lighted with "Sugg's" high-pressure upright burner lamps, some 135 in number, giving 30 candles to the foot of gas; they are single-burner lamps with clusters on the centre of the bridges, and have been in lighting for about eight years, having been installed and maintained by the South Metropolitan Gas Company. The gas is compressed by separate gas and water driven machinery on the bridges, except at Blackfriars, where the gas is taken direct from the high-pressure main of the Gas Light and Coke Company. The aggregate length of the four bridges is about one mile, the widths of the roadways varying from 45 ft. to 70 ft.

An experimental three-burner inverted "Keith" high-pressure lamp has been fixed in Fleet Street, consuming the same amount of gas as the single burner, and gives, it is stated, a like illumination, viz., 1,500, but with a better diffusion. Its improvement is, that if one mantle breaks, the remaining two will give a good light until a new mantle is put on, instead of the lamp being out. The annual cost of the lamp would be the same as the single burner.

In Queen Victoria Street, on the rest by Queen Street, an experimental four-burner "Keith" high-pressure inverted lamp has been fixed in one of the existing high-pressure lanterns in place of the two upright burners. The consumption of the four burners is the same as the upright burners, viz., 20 cubic feet per hour. It is claimed that the candle-power is increased about 50 per cent, viz., 45 instead of 30 candles per cubic foot of gas, giving a total of 900 instead of 600 candles. The maintenance cost would be the same.

The "Keith" Lamp.

For the purpose of comparison, the "Keith" inverted lamp gives 60 candles per foot of gas consumed, against 51 to 53½ candles and 25 ft. consumption against 28 ft. of the "Graetzin," therefore :—

> "Keith" single burner, 25 ft. per hour, at 60 candles per foot as tested on photometer, equals 1,500 candles.
>
> "Graetzin" single burner, 28 ft. per hour at 51 to 53½ candles per foot, as claimed by Berlin figures, equals 1,400 to 1,500 candles.

A specimen of the newest form of "Graetzin" lamp with three burners has also been fixed in Fleet Street on the existing compressing plant, giving an illuminating value of about 4,400 to 4,555 candles, with a consumption of about 84 cubic feet of gas per hour.

Incandescent Gas Lighting—Low Pressure.

The number of gas lamps, principally single burners of the upright type, at the end of the year 1908 was 2,640—each consuming 4¼ cubic feet of gas per hour—the illuminating power being 65 to 70 candles. Owing to the narrowness of the side streets the lamps are nearly all fixed on brackets about

60 ft. to 70 ft. apart at a height of about 2 ft. from roadway to burner, the annual cost of each lamp with gas at 2*s*. 5*d*. per 1,000 cubic feet being £3 10*s*. 2*d*. This cost includes maintenance of mantles, &c., but does not cover capital charges. A few 2, 3, and 5 burner lamps are fixed upon standards on the rests in the main roads and squares.

Low-Pressure Inverted.

The only low-pressure inverted gas lamps in the City are a few "Carpenter" 1 and 2 burner lamps on trial, with a stated consumption of 4 and 8 cubic feet per hour, and 100 and 200 candle-power respectively, being a claimed efficiency of 25 candles to the foot of gas consumed.

The price of gas for public lighting up to Midsummer was 2*s*. 5*d*. per thousand cubic feet, but this amount was then reduced by 1*d*., and a further reduction of 2*d*. per 1,000 cubic feet will be made as from January 1st, 1910, when the Gas Light and Coke Company will reduce the illuminating value of their gas from 16 to 14 candles, under their Bill now before Parliament, which has passed the third reading of the House of Commons.

The effect of these reductions will be to decrease the annual cost of the newest type of high-pressure inverted gas lamp, as in Fleet Street, from £16 10*s*. to £15 2*s*. 6*d*., and all other gas lamps proportionately.

The Illumination of the White House, Washington.

The methods of lighting adopted in buildings of great historic value, such as the White House in Washington, the dwelling of the President of the United States of America, are always of interest. It is, one would suppose, in such cases as this that the services of the ideal illuminating engineer would be specially acceptable. In a building of such unique importance the question of expense is probably of relatively little consequence, and the method of illumination used is chiefly subservient to æsthetic and special local conditions, which often demand a peculiar degree of taste and judgment on the part of the designer.

The two illustrations on the opposite page, which are taken from *Popular Electricity*, may therefore be of some interest to our readers. The lighting of the President's house, it is stated, is exclusively electric. The fixtures, &c., utilized in the large rooms of the building are of a massive and impressive character; in Fig. 2, for instance, will be seen one of the heavy prismatic chandeliers, surrounded by "electric" candles. Judging from other views of the White House, electric candles of this kind seem to be somewhat extensively employed (they are, for instance, largely used in the famous state dining-room), although it will be recalled that they have been censured, from the æsthetic standard in several quarters (*Illuminating Engineer*, Feb., 1909, p. 125). However, it may well be that custom and tradition often invite, and indeed demand, the use of types of fixtures which are not in themselves the highest form of art.

The lighting of the grounds, and in particular the grounds surrounding the house, is said to be of a particularly lavish character. This is on account of the security it affords to the President. Good lighting of the public srteets, it has been remarked, is of special value in assisting the police and preventing the possibility of crime. In this case such considerations are of paramount importance, and the powerful lighting adopted serves to prevent any person approaching the President's house by night without being observed by the detectives and police officers on guard.

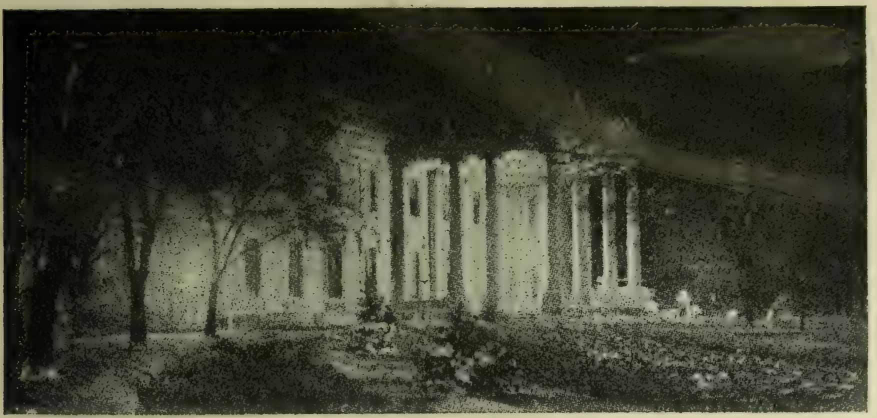


FIG. 1.—Illumination of Outside of White House, Washington.

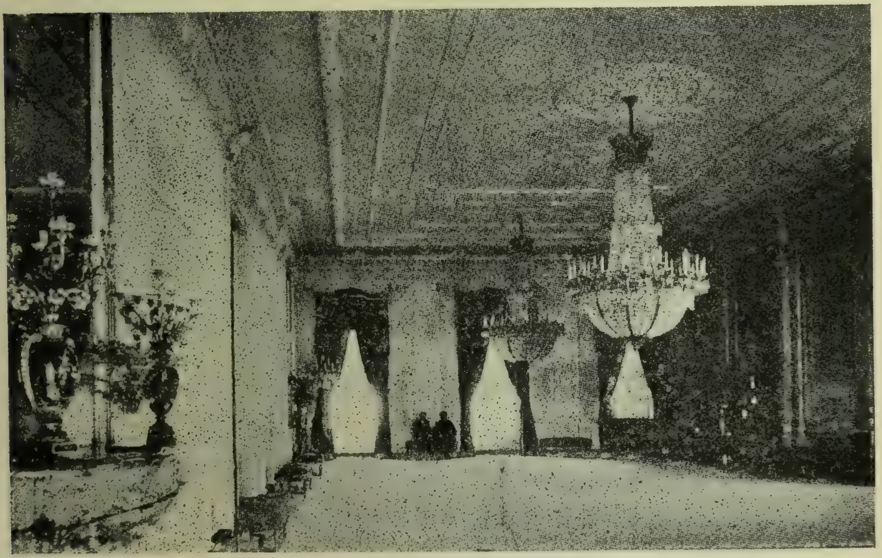


FIG. 2.—Illumination of Hall in White House, showing Chandelier.

Further Papers to be presented at the Third Annual Convention of the Illuminating Engineering Society in the United States (held in New York, Sept. 27th, 28th, and 29th.)

In addition to the varied and interesting series of papers to be read at this Convention which were published in our last number, we are now informed that the following additional papers have been added to the list:—*Auer von Welsbach*, by Prof. W. S. Barrows; *Notes on Chemical Luminosity*, by Angelo Simonini; *The Light of the Firefly*, by Dr. H. E. Ives and Dr. W. W. Coblentz; *Arc-lamps*, by W. D'A. Ryan; *The Physiological Effects of Radiation*, by Dr. C. P. Steinmetz; and *Instruction in Illuminating Engineering at Cornell University*, by F. K. Richtmyer.

The Simple Explanation and Calculation of Fundamental Photometrical Terms.

By Dr. L. Bloch.

(*Continued from page 518.*)

In order to represent graphically the intensity of light in different directions in space we do not project the light reflected from the surface of a hollow sphere inwards, as in the analogy of a sand-deposit. Instead of this we trace out the light in every direction in space by means of vectors, the length of which is proportional to the intensity of the ray to which it corresponds. The surface traced out by the terminations of these vectors furnishes a picture of the distribution of light in all directions in space, and is called a "photometrical solid." It may, however, be noted that neither the cubic contents of the volume of such a solid nor its surface is a quantity of any value in the photometrical sense, although this is sometimes erroneously thought to be the case.

By cutting this "photometrical solid" by a vertical plane containing the vertical axis of the light-source we obtain what is known as the "polar curve of light-distribution." This curve represents the distribution of light in all directions such as fall within this plane. If the same result is obtained for any of these vertical planes the source of light is said to be symmetrical; in this case the photometrical solid could be obtained by merely rotating the section through a vertical plane about its vertical axis. If, on the other hand, the source of light is not symmetrical, then the polar curve obtained by adopting different vertical sections will not be the same.

Now in order to compare, in an exact manner, the properties of different sources, it is clearly insufficient merely to state the *maximum intensity*, in whatever direction in space this may occur. On the contrary, we must refer to a quantity which includes the entire amount of light thrown out in all directions. This quantity is termed, as we have seen, the total light-flux Φ_0. As, however, in practice we almost invariably deal with light-intensity, and not light-flux, it is customary to use an equivalent quantity known as the "*mean spherical candle-power.*"

This quantity can also be very simply explained by the aid of the sand-blast analogy. As we have seen, the thickness of the layer of sand at any particular place on the inner surface of the sphere of unit radius corresponds to the intensity of light radiated in that particular direction. In the same way the total mass of sand distributed over the entire inner surface of the sphere corresponds to the total flux of light from the source. Imagine, now, that the entire mass of sand, instead of being distributed irregularly, is spread over the inside of the sphere uniformly thick, this uniform thickness will then correspond to what is known as the mean spherical candle-power. This term represents the mean illumination over the whole surface of the sphere of unit radius; the mean spherical candle-power may thus be defined as "that intensity which would be given out by any source which produces the same total amount of light as at present, but distributes it uniformly in all directions." As a sphere of unit radius has a superficial area of the value of 4π the connexion between the mean spherical intensity I_0 and the total flux of light Φ_0 (which corresponds to the total mass of sand) is as follows:—

$$\Phi_0 = 4\pi I_0$$

In many practical cases of illumination, however—for example in street lighting—we are only concerned of the

light thrown downwards, that is to say the light radiated over the lower hemisphere. It is therefore desirable to compare different lamps in terms of light radiated over the lower hemisphere only. In the same way we utilize, in making this comparison the conception of *mean hemispherical intensity*, denoting thereby, the mean illumination on a hemispherical surface of unit radius, at the centre of which the source is supposed to exist; this quantity again corresponds to the average depth of sand on the lower hemisphere. As the superficial area of the hemisphere of unit radius is 2π the connexion between the mean hemispherical intensity $I_{\smile}$ and the flux of light impinging on the lower hemispere, $\Phi_{\smile}$ will be,

$$\Phi_{\smile} = 2\pi I_{\smile}$$

By the aid of our analogy we can also immediately deduce a means by which mean spherical or mean hemispherical intensity can be calculated when once the polar curve of light distribution from a source is known. Consider a small surface-element dF on the inner surface of a sphere of unit radius, and suppose, as usual, that the thickness of sand corresponds to the intensity in this direction I. The total mass of sand on this surface element will then correspond to the illumination I.dF. If now we sum up the illumination on such surface-elements over the entire surface of the sphere and then divide by the area of this surface 4π, we obtain the mean depth of sand and consequently arrive at a definition of the mean spherical candle power as follows :—

$$I_0 = \frac{1}{4\pi} \Sigma\ I.dF = \frac{1}{4\pi} \int I.dF.$$

Just in the same way the mean hemispherical intensity is obtained by considering the surface of a hemisphere of unit radius and is expressed as follows :—

$$I_{\smile} = \frac{1}{2\pi} \Sigma\ I.dF = \frac{1}{2\pi} \int I.dF.$$

In the case of a symmetrical source of light the depth of sand on every individual surface element will vary, but still the quantity "I" can be regarded as the same over any small zone of this sphere which is bounded by two indefinitely close parallel planes. By considering the sum of small areas of this description we can arrive at the total light over the surface of a sphere. For instance from Fig. 3 it appears that :

$$dF = r\ d\alpha\ 2\pi\ r.\sin\alpha = 2\pi\ r^2 \sin\alpha\ d\alpha$$

where $r\ d\alpha$ is the breadth and $2\pi r \sin\alpha$ the circumference of the small zone referred to.

In our case we have to do with a sphere of unit radius and therefore we can obtain for the mean spherical intensity the relation :—

$$I_0 = \frac{1}{4\pi} \sum_{\alpha=0}^{\alpha=\pi} I.\ 2\pi \sin\alpha\ d\alpha = \frac{1}{2} \sum_{\alpha=0}^{\alpha=\pi} I \sin\alpha\ d\alpha.$$

and in the same way, for the mean hemispherical intensity, the relation

$$I_{\smile} = \frac{1}{2\pi} \sum_{\alpha=0}^{\alpha=\pi/2} I.\ 2\pi \sin\alpha.\ d\alpha = \sum_{\alpha=0}^{\alpha=\pi/2} \sin\alpha\ d\alpha.$$

From this formula we can derive various processes to enable the mean spherical and hemispherical intensities to be calculated from the polar curve of light-distribution. Previous to the last four years the so-called "Rousseau method" was almost exclusively employed (see Rousseau, *La Lumière Electrique*, Vol. 26, page 60). Since this time, however, a variety of other methods have been introduced—which is an encouraging proof of the fact that illumination receives much closer attention than it used to do. In this article some account is given of these various methods and of their respective convenience in practical use.

The Rousseau process is derived by the substitution of the height dh in the above formula for d F, instead of r. dα. sin α (see Fig. 3); in this way we obtain for the sphere of unit radius the following relations :—

$$I_0 = \frac{1}{2} \sum_{h=+}^{h=-1} I.\ dh, \quad \text{and} \quad I_{\smile} = \sum_{h=+1}^{h=o} I.\ dh$$

In this way we obtain the mean spherical and mean hemispherical intensities as the sum of a number of small rectangles of which the bases are the heights of the zones of the sphere, and the heights are the corresponding intensities over these zones. It is, therefore, only necessary to project

the intensities corresponding to each point on the sphere vertically outwards from the diameter of this sphere as base line, as in Figs. 2 and 3. The line which traces out the terminations of the ordinates representing these intensities forms the so-called "*Rousseau curve*"; the area existing between this curve and the base line is equivalent to the quantity $\Sigma I. dh$ in the above formula.

This area, which can be integrated by the aid of the planimeter or by any other convenient means, when divided by the true length of the diameter as base line gives us the mean spherical or mean hemispherical candle-power; the number of ordinates set up in this way in order to obtain the Rousseau curve is immaterial. It only affects the accuracy of the process and not the principle. It is convenient, for instance, to divide the radius of the sphere into 10 equal parts.

When, however, we are only concerned to know the value of the mean spherical or mean hemispherical intensity, and do not particularly wish to acquire a knowledge of the Rousseau curve, we can dispense with the tracing out of this curve and the determination of the area, as I have already shown in the *Elektrotechnische Zeitschrift* (1905, page 1075) and in my book on this subject, of which I have previously made mention. Suppose that we divide the diameter of the unit sphere K G into 20 equal parts (see Fig. 2), each 1 centimeter in length. From the middle point of each part we now proceed vertically from this diameter K G to the corresponding semicircle and take from the polar curve of light-distribution the corresponding value of the intensity I, which is associated with the height in the above formula. The 20 values of I obtained in this way are now added up (their sum in Fig. 2 amount to 7,800), and divided by 20. The resulting value (390 in Fig. 2) is the mean ordinate of the Rousseau curve, and therefore represents the mean spherical intensity. In exactly the same way we may obtain the mean hemispherical intensity (670

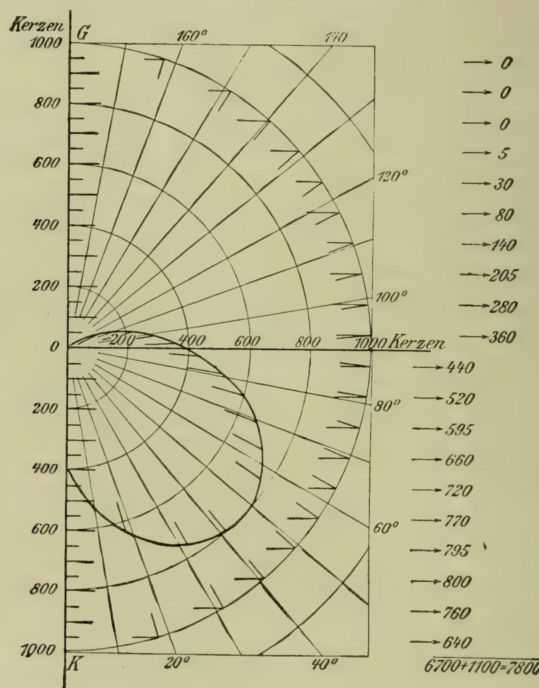


Fig. 2.

in Fig. 2) if we utilize only the sum of the 10 values of I in the lower hemisphere and divide by 10.

This process seems to me to be the simplest for the determination of mean spherical and mean hemispherical intensity. If the polar curve of light-distribution is drawn out on squared paper with millimeter-divisions it is only necessary to draw the semi-circle referred to above. The accuracy obtainable naturally depends on the number of individual values of the intensity taken, but the adoption of 20 values for I_o and 10 values for $I_{\smile}$ will be amply sufficient for all ordinary purposes.

Another method has recently been proposed by Wohlauer (*Illuminating Engineer*, New York, February, 1909), and apparently simultaneously by Weinbeer (*Elektrotechnischer Anzeiger*, February 14th, 1909, p. 136), and subsequently also by J. K. Sumec (*Elektrotechnik und Maschinenbau*, April 4th, 1909, p. 319). The process in question can also be described as relatively simple. The polar curve of light distribution is here set out on a scale of angles within the limits of 90° or 180° as the case may be, and is divided into equal angular intervals of 10°. The values of the quantity I sin α (see Fig, 3) corresponding to the angles, 5, 15, 25 degrees, &c., are now obtained from the light distribution curve and the sum of the individual terms from 5° to 85° or

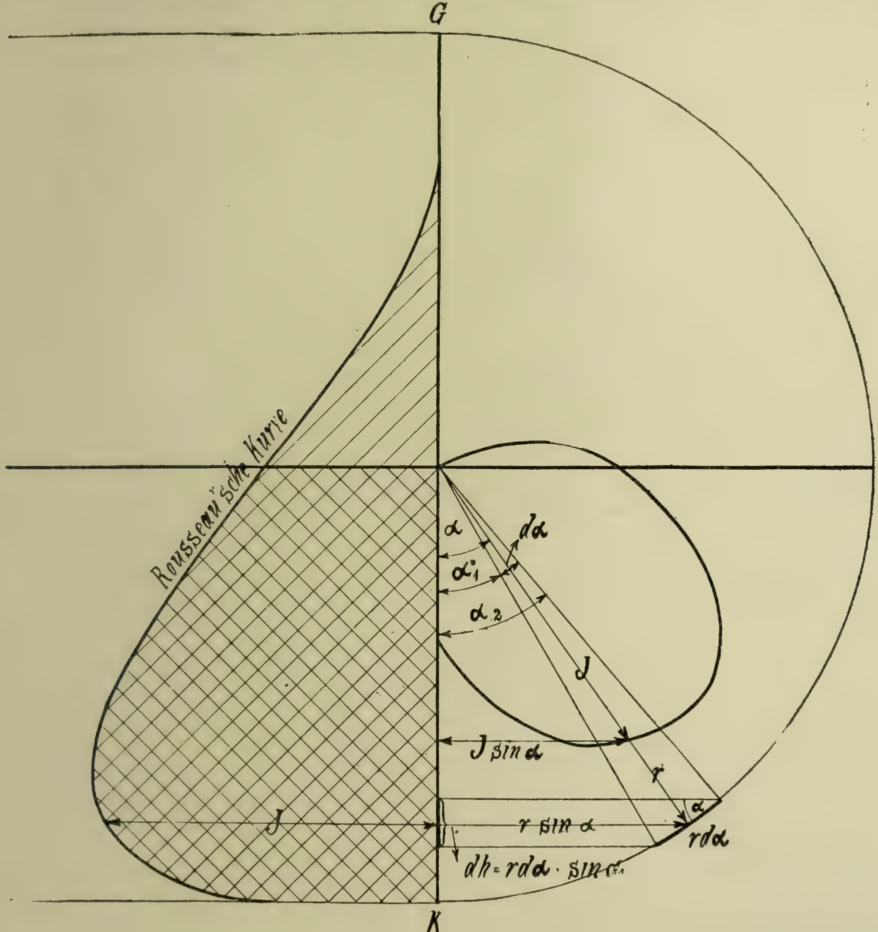


FIG. 3.

5° to 175° added, this sum is then multiplied by $d\alpha$ or $\frac{d\alpha}{2}$. In this way we can obtain the mean spherical and mean hemispherical intensity. The quantity $d\alpha$ must in this case be expressed in circular measure. As in this process a scale of angles, or a protractor is necessary and it does not seem to be quite so simple as that described above. The process is facilitated by the use of a special "fluxo-light" paper recommended by Wohlauer, on which both the angular scale and rectangular millimeter co-ordinates are already printed.

Another construction arising from the same formula was given last year by Kennelly (*Electrical World*, 1908, No. 13). In this case equal angular spaces, $d\alpha$, are also taken, and for each particular angle a small arc of the circle is struck with the corresponding intensity I as radius. The length of this arc is $I.\ d\alpha$ and its projection on the vertical axis is $I.\ d\alpha \sin \alpha$. By a special construction involving a displacement of the centre of each of these circles, the individual arcs are formed into a continuous curve, embracing the angular region from 0° to 90° or 180°, which is projected on a vertical axis; the length of this projection will be the quantity $\Sigma\, I \sin \alpha\, d\alpha$. In accordance with the above formula this enables us to obtain the mean hemispherical or the double mean spherical candle power. For practical purposes, however, this construction is too complicated and tedious, if one seeks to obtain the same order of accuracy as in the case of the methods formerly mentioned.

The methods described above are intended to enable us to calculate the mean spherical and mean hemispherical intensity by the aid of a polar curve of light distribution. It may, however, often occur that the shape of this curve does not interest us, and we merely wish to obtain the mean spherical and mean hemispherical intensity in the simplest possible manner. Among the varieties of apparatus designed for this end the Ulbricht globe photometer deserves special mention (see this Journal, vol. I., 1908, pp. 274, 553, 801, 895, and 1031); still, this instrument is not to be found in all laboratories as yet, and sometimes the use of spheres of the smaller diameters will be found not to be reliable, in practice, for the testing of sources of light of considerable dimensions. Recourse may therefore be had to certain other methods which enable the mean spherical intensity, &c., to be worked out, without it being at the same time necessary to obtain the polar curve of light distribution; instead, we merely measure the light in certain prescribed directions.

For this purpose the method described by L. W. Wild (*Electrician*, 1905, p. 936) is of interest. According to Wild it is only needful to measure the intensity at intervals of 30 degrees. In this way he obtains an accuracy approaching ½ per cent in the case of fairly uniform curve of light distribution, and even in the case of very unsymmetrical sources of light, such as arc lamps, the accuracy still only seldom falls below 3 per cent.

The explanation of this process depends upon the formulæ given above for the Rouseau curve, namely :—

$$I_o = \frac{1}{2} \sum_{h=+1}^{h=-1} I\ dh \text{ and } I_{\overline{\overline{\ }}} = \sum_{h=+1}^{h=o} I\ dh$$

Now, since $dh = r\,(\cos\alpha_1 - \cos\alpha_2)$, in the case of our sphere of unit radius, we also obtain

$$I_o = \frac{1}{2} \sum_{\alpha=0}^{\alpha=180^\circ} I\,(\cos\alpha_1 - \cos\alpha_2)$$

and

$$I_{\overline{\overline{\ }}} = \sum_{\alpha=0}^{\alpha=90^\circ} I\,(\cos\alpha_1 - \cos\alpha_2)$$

We see, therefore, that we obtain our mean intensity by the summation of a series terms each of which contain the difference of the cosines of two successive angles. The interval of the angles is immaterial, it is only needful that the number should be sufficiently high to make the process reasonably accurate, and, as stated above, intervals of 30° usually suffice.

Upon this supposition we obtain the series :—

$$I_{\circ}=\begin{cases} I_{0^\circ}(\cos 0^\circ-\cos 15^\circ)+I_{30^\circ}(\cos 15^\circ- \\ \cos 45^\circ)+I_{60^\circ}(\cos 45^\circ-\cos 75^\circ)+ \\ I_{90^\circ}(\cos 75^\circ-\cos 105^\circ)+I_{120^\circ}(\cos \\ 105^\circ-\cos 135^\circ)+I_{150^\circ}(\cos 135^\circ- \\ \cos 165^\circ)+I_{180^\circ}(\cos 165^\circ-\cos \\ 180^\circ \end{cases}$$

Strictly speaking the angles 0° and 180° should be replaced by 7·5° and 172·5°, but this error is so trifling in the total summation as to be quite negligible. The individual factors by which each of the values of the intensity must be multiplied can be obtained for trigonometrical tables. Substitute these values the series becomes :—

$$I_{\circ}=\begin{cases} 0{\cdot}017\ I_{0^\circ}+0{\cdot}1295\ I_{30^\circ}+0{\cdot}224\ I_{60^\circ}+ \\ 0{\cdot}259\ I_{90^\circ}+0{\cdot}224\ I_{120^\circ}+0{\cdot}1295\ I_{150^\circ}+ \\ 0{\cdot}017\ I_{180^\circ}. \end{cases}$$

That is :—

$$I_{\circ}=\begin{cases} 0{\cdot}017\ (I_{0^\circ}+I_{180^\circ})+0{\cdot}1295\ (I_{30^\circ}+I_{150^\circ}) \\ +0{\cdot}224\ (I_{60^\circ}+I_{120^\circ})+0{\cdot}259\ I_{90^\circ}. \end{cases}$$

In a similar manner the mean hemispherical intensity can be calculated from the values of the intensity at 0° and 30°, 60°, 82·5° respectively. In this case we obtain the relation :—

$$I_{\smile}=\begin{cases} I_{0^\circ}(\cos 0^\circ-\cos 15^\circ)+I_{30^\circ}(\cos 15^\circ \\ -\cos 45^\circ)+I_{60^\circ}(\cos 45^\circ-\cos 75^\circ) \\ +I_{82\cdot5^\circ}(\cos 75^\circ-\cos 90^\circ) \end{cases}$$

or

$$I_{\smile}=2\begin{cases} 0{\cdot}017.I_{0^\circ}+0{\cdot}1295.(I_{30^\circ}+I_{82\cdot5^\circ})+ \\ 0{\cdot}224\ I_{60^\circ} \end{cases}$$

As an example of the application of this approximate method the mean spherical and mean hemispherical intensity corresponding with the curve of light-distribution shown in Fig. 3 can now be calculated. From this curve we obtain the values :—

$I_{0^\circ}=400$ H.K.	$I_{90^\circ}=400$ H.K.
$I_{30^\circ}=745$,,	$I_{120^\circ}=55$,,
$I_{60^\circ}=745$,,	$I_{150^\circ}=0$,,
$I_{82\cdot5^\circ}=505$,,	$I_{180^\circ}=0$,,

From these we can calculate the mean spherical and mean hemispherical intensity as follows :—

$$I_{\circ}=0{\cdot}017\ (400+0)+0{\cdot}1295\ (745+0)+0{\cdot}224\ (745+55)+0{\cdot}259\times400=386\ \text{H.K.}$$

$$I_{\smile}=2\begin{cases} 0{\cdot}017\times400+0{\cdot}1295\ (745 \\ +505)+0{\cdot}224\times745 \end{cases}=672\ \text{H.K.}$$

It will be seen from Fig. g that $I_{\circ}$ equals 390 candle-power, and $I_{\smile}$ equals 670 candle-power, so that the above results only differ by − 1 per cent and +0·3 per cent. respectively.

A method which in principle follows closely that described by Wild has been mentioned by Weinbeer in this journal (July, 1908, p. 559); in order to achieve exactitude Weinbeer utilizes angles at intervals of 10° and works with values of the intensity corresponding to 5°, 15°, and so forth. The author has also constructed a special form of slide-rule by which the addition of the products is done mechanically; a special slider is provided for each of these products with a special scale on which the divisions corresponding with intensity are in value proportional to the multiplying coefficient. The terms on each scale are then added together by moving the sliders in the usual way and the mean hemispherical intensity is obtained by the summation. The same calculation can be undertaken for the upper hemisphere and the average of this and the mean lower hemispherical candle-power gives the mean spherical candle-power. It appears however that, once one has obtained the coefficients required in Wild's formula, this addition may be done in what is probably as simple and speedy a manner by the use of an ordinary sliding rule.

Cases often occur in which we do not wish to know the mean spherical and mean hemispherical intensity exactly, but only wish to obtain an approximate idea by the rapid survey of a few measurements. With this object in view, the author has simplified the Wild formula described above, so as to obtain the spherical and hemispherical intensity by the aid of only 6 or 3 single measurements ; even in the case of somewhat unsymmetrical curve of light-distribution results to an accuracy of 5 per cent can usually be obtained by this formula, which is very easy, and carried in the memory.

The intensity at angles of 30°, 60°, and 80° from the vertical axis are in this case utilized if only the mean hemispherical

intensity is wanted; if, in addition, the mean spherical intensity is desired, the measurement at 100°, 120°, and 150° should be taken. For the calculation of these quantities the following formula applies :—

$$I_o = \tfrac{1}{8}\{I_{30°} + (2 \times I_{60°}) + I_{80°} + I_{100°} + (2 \times I_{120°}) + I_{150°}\} \quad I_{\smile} = \tfrac{1}{4}\{I_{30°} + 2I_{60°} + I_{80°}\}$$

As an example of this process we may again calculate results from the curve shown in Fig. 2. From this curve we take the following figures :—

$I_{30°} = 745$ H.K.	$I_{100°} = 265$ H.K.
$I_{60°} = 745$,,	$I_{120°} = 55$,,
$I_{80°} = 535$,,	$I_{150°} = 0$,,

From this we obtain :—

$$I_o = \tfrac{1}{8}\{745 + 2 \cdot 745 + 535 + 265 + 2 \cdot 55 + 0\} = 393 \text{ H.K.}$$
$$I_{\smile} = \tfrac{1}{4}\{745 + 2 \cdot 745 + 535\} = 692 \text{ H.K.}$$

It will be seen, therefore, that in this case the application of this approximate formula leads only to errors of 0·8 per cent and 3·3 per cent respectively.

In this article the writer has sought to explain how the fundamental terms in connection with illumination can be explained in the simplest possible manner. In addition he has summarized the chief processes by which the mean spherical and mean hemispherical candle power can be obtained. Some of these, it will be seen, are particularly simple and easy to manipulate, and may be found of interest to the readers of this journal.

Church Cross Lighting.

We notice in a recent number of *The Progressive Age* a reference to a interesting application of electric lighting for decorative purposes at one of the churches in Denver, in the United States. In this church a golden cross is suspended from the Gothic roof arch. The cross is built of sheet metal finished in gold leaf on the visible surface, and carries seven 8-candle-power frosted electric bulbs on the vertical arm and four on the horizontal arm. Its appearance when illuminated will be judged from the accompanying illustration. In view of the discussion which has taken place in this journal regarding the applicability of electric light for decorative purposes or for the production of special effects in churches, this may be of interest to our readers.

The question as to how far it is legitimate to utilize electric lighting to produce spectacular effects in churches offers very debatable ground for discussion.

We observe that a recent number of *The American Review of Reviews* had a paper dealing in some detail with the development of the Illuminating Engineering movement in the United States.

This paper is now abstracted in a full page of the English *Review of Reviews* for September. This may be regarded as striking evidence of the interest taken in the question in this country and its importance to the general public.

Colliery Illumination.

By an Engineering Correspondent.

This article is intended to epitomize methods employed in illuminating collieries, and is the result of the writer's experience during some years of practical working among leading English coal pits. An attempt is made to set forth judicially the advantages and disadvantages of the various classes of apparatus in use at the present day; of these perhaps portable electric lamps deserve the greatest share of attention.

CLASSES OF LAMPS.

1. The Davy lamp and its modifications, burning parafin, colza, and similar oils.
2. Candle lanterns.
3. Acetylene lamps.
4. Electric primary battery lamps.
5. Electric secondary battery lamps,
6. Higher voltage lamps connected to electric supply.

1.—DAVY LAMPS AND THEIR MODIFICATIONS.

The construction of this class of lamp is too well known to require description in an article in this journal, but some account may be given of the advantages and disadvantages involved in their employment in mines (collieries in particular) where dangerous or obnoxious gases are encountered, or flooding is a danger to be feared. The obvious and admitted advantage of the Davy principle is that the hot gases resulting from combustion are cooled before reaching the surrounding atmosphere, and so cannot ignite it if inflammable. Further, owing to the necessity for the presence of a certain proportion of oxygen, the lamp gives automatic indication by a decreased flame area or luminosity when non-supporting gases are present. Thus, the workman (coal-hewer) and his overseers receive warning when the atmosphere of that particular part of the working varies to an appreciable extent from the normal.

Lamps of this class, however, are liable to extinction from accidental causes—*e.g.*, upsetting, excessive air velocity, and immersion in liquid. When such a cause of extinction has

Fig. 1.—Unbonnetted "Davy" Lamp.

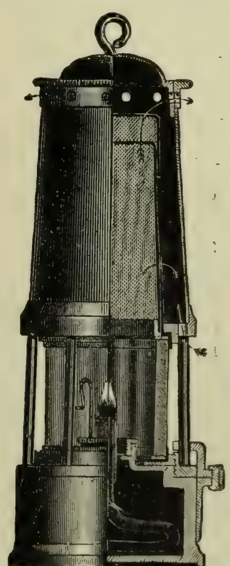


Fig. 2.—Bonnetted Clanny Lamp.

been removed (presumably in the dark) the lamp has to be relighted, and there are many devices of varying merit for accomplishing this by electrical or other means. But it would obviously be better if the lamp were not liable to accidental extinction.

The principle involved in the Davy lamp, however, supplies us with practically the only reliable detector for marsh gas and carbonic acid that has hitherto been known, as the luminosity of the lamp is readily affected by the presence of the above gases.

The accompanying illustrations show the latest modifications of the Davy lamp, and is inserted by the courtesy of the manufacturers (Messrs. John Davies & Son, Derby).

2.—THE CANDLE LANTERN.

Candle lanterns are used in many collieries where explosive gases are not to be found. They have the advantage of giving more light than most lamps of the preceding type, but cannot be trusted where there is the slightest possibility of the occlusion or intrusion of inflammable gases; this type will, of course, be extinguished under conditions that similarly affect the Davy lamp. It has the further disadvantage of giving out much heat and moisture, and burning up oxygen at a higher rate.

Again candles are very expensive, and are really impracticable where the temperature is above a certain point—which point is soon reached in a low-roofed enclosed working.

3.—ACETYLENE LAMPS.

Acetylene lamps are very much in vogue on the Continent, and are obtaining some degree of favour in this country. They give a brilliant light, pleasant to work by, but are open to the same objections respecting atmospheric condition, accidental upsetting, &c., deoxygenizing, moistening the atmosphere as other lamps; on the other hand it is claimed that, for a given amount of light, the oxygen used up will be less. In addition the "stiffness" of the flame, which is stated not to be easily blown out by a gust of wind, may also be considered an advantage.

Accidental causes may lead to the extinction of the light without the complete cessation of formation and emission of acetylene gas and allied poisonous compounds. In cases where the miner is unable either to leave the working or arrest the generation of gas, this is very serious.

4.—ELECTRIC PRIMARY BATTERY LAMPS.

This class of lamp has been tried in English collieries, but the writer is not aware that it has met with marked success. This may be because it depends upon the removal of its component parts involving expenditure of material and labour to such an extent that it cannot compete favourably with other classes of lamps.

It has, however, many advantages over the preceding types—advantages which it shares with secondary battery lamps, to which reference will next be made.

Mr. S. F. Walker has produced a lamp on this principle; from this he obtained excellent results, the main difficulty, however, being the supply of necessary materials in sufficient bulk to carry out the scheme on a practical scale. He states that with due economy in the residue of the battery discharge, it would be possible to maintain 1,000 primary battery lamps at the rate of $\frac{1}{2}d.$ per lamp per shift, including whatever renewals might be required.

5.—SECONDARY BATTERY LAMPS.

This class the writer believes to have a very important future. It has been thoroughly and severely tested for a period of at least ten years, and many thousands are actually in use in some of the principal collieries in Great Britain, having survived the keen, and not always friendly, competition of its ozygen-burning brothers. One type of electric hand lamp to which special reference may be made is that brought out by the Sussman Electric Miners' Lamp Co. in 1898, and invented by the present manufacturer, Mr. W. E. Gray, to whom the writer is indebted for the accompanying illustration.

This lamp consisted essentially of a strong and cheap metal case, fitted

with a stout steel lid attached thereto.

The secondary battery is fitted loosely in the case, and the current is carried by means of flexible permanent connexions of the bulb or lamp through a simple gas-tight switch situated on the lid of the case.

The external form of the lamp can be seen in Fig. 3. The advantages of this type of lamp are as follows :—

(*a*) No oxygen is consumed.

(*b*) A more intense and a whiter light is obtained than with most other types.

(*c*) The temperature of the atmosphere is not affected.

(*d*) Entire absence of fire-risk.

(*e*) Is cleaner, and will not be extinguished if upset.

(*f*) *Requires less attention in the lamp room and less rigid inspection.*

In certain well-known collieries in the North of England many thousands of these lamps have been in use for ten years, at a low cost per lamp per shift, including renewal, batteries, lamps, and other parts.

The ideal electric miners' lamp must be able to burn under all possible conditions of atmosphere excepting, of course, excessive heat.

It must burn in any position, and all electrical connexions be insulated from the case of the lamp and from accidental contact with the outside.

It must carry either two filaments in one electric bulb or two separate bulbs, so that if one fails, the remaining filament is available.

It must not exceed 3 lb. in weight, or be suspended in such a way as to place too great a strain on any portion of it, or have any corners or projections that can be readily knocked off.

Although it must be securely locked it must be readily opened for either the renewal of lamps or the charging and maintenance of the battery. These features are embodied in a more recent type of lamp shown diagrammatically in Fig. 4.

This lamp is constructed mainly of aluminium, to combine lightness and strength. The battery is enclosed in a box tightly screwed down and hermetically sealed to prevent the slightest possibility of gas escaping during discharge. This is important in view of the fact that in other accumulator lamps the inflammable gases resulting from discharge of the battery are allowed to escape.

The escape of these gases may lead to the formation of an explosive mixture, and cases of ignition, when the switch controlling the lamp is operated, have occurred.

The top of the accumulator is also the base on which the glass dome containing the electric bulb rests.

The terminals from the battery project above the ebonite or vitrite top inside the dome where the simple rotary switch is fitted. Thus it will be seen that all contacts are made and broken in the air-tight chamber, formed when the lantern is held down on to the base by the springs and ring shown in our illustration.

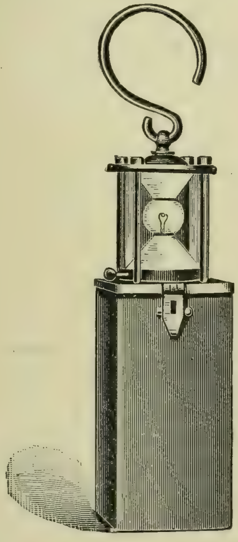


FIG. 3.—Gray's Sussmann Electric Lamp.

The lamp is finally locked by a grub screw in the top ring.

This lamp can be burnt in any position, in any gas, in any non-corrosive liquid, without danger to either the lamp or its surroundings.

The battery being screwed down into the case when the lamp is made up does not require attention (beyond charging) for many months. New bulbs and glasses can be fitted in very

much less time than is possible with any other form of lamp. In fact, it is the inventor's claim that all the parts, including the accumulator, can be renewed in less than half a minute—a quite impossible feat in any other system.

This, of course, not only reduces the first cost and that of repairs, but diminishes by 50 per cent the labour required in the lamp cabin; even assuming that the collieries buy the lamps complete, and lay themselves out for all renewals and maintenance.

The manufacturers find in practice that while making due allowance for normal usage in colleries, the lamp can be charged and maintained, including renewal of batteries and lamps, at a total cost, including labour, charges on plant, &c., of 1*d*. per lamp per 48 hour week for 2,000 lamps.

Various devices are extant to remove the one evident disability of electric lamps, which will occur to the observer. namely that the electric lamp will not of itself detect the presence of dangerous gases.

The devices employed more or less successfully are as under, and can be divided into the following types :—

1. Apparatus depending upon the increased luminosity of an incandescent filament, and the accompanying change of an electrical resistance.
2. Apparatus depending upon the heat generated when platinum and the like in a highly divided or spongy form meets hydrogen or methane.
3. Apparatus depending upon the discoloration of lime in a state of suspension in liquid.
4. Liquefaction of quicklime.
5. Variation of weight due to absorption or giving up of chemical constituents.
6. Apparatus depending upon the unequal diffusion of gases of different specific gravities through a porous medium.

The advantages of these existing forms of apparatus can be briefly compared as follows :—

1. *The indication depending on difference in luminosity of incandescent filament.*—The obvious objection is, that the filament must be exposed to the action of the dangerous gases, and either burn away or ignite the gas. They also require a large amount of electric current, thus increasing the total weight of the lamp. This is undesirable, and furthermore accurate per cent tests can hardly be obtained.

2. *The heating of finely divided platinum in certain inflammable gases.*—The method adopted is to impregnate cotton-wool and the like with spongy platinum or attach the metal to any convenient device for registering temperature. The platinum, however, soon becomes oxidized, and therefore useless as an indicator.

3. *The discoloration of liquids containing lime and the like.*—This system is only applicable for CO_2 gas, which must be passed through the liquid, which it is not always convenient to do in practice.

The same objection exists to the use of quicklime mentioned in Classes 4 and 5.

6. *The varying rate of diffusion of different gases through a porous medium.*—The writer believes that in this class lies the solution of the important problem facing the manufacture of electric miners' lamps, and has designed a simple apparatus that will detect quantitatively and qualitatively the presence of any gas or gases, whose specific gravity varies appreciably from that of air.

In the case of instruments of the Ansell type the difficulty has hitherto been that, while an accurate indication is obtained at the first reading, all subsequent readings must be more or less inaccurate as long as the apparatus remains in the atmosphere in which the test is made. A brief description of the instrument is desirable. (See Fig. 4.)

The porous medium forms part of a wall of an enclosed chamber, with which any convenient method of registering the internal pressure is associated. When the apparatus filled with air is taken into an atmosphere of different specific gravity, pressure inside the chamber varies and is duly recorded. This pressure however, rapidly becomes equal to that of the surrounding atmo-

sphere as the heavier gas finds its way through the pores of the material. It is necessary, therefore, in order to obtain a second accurate reading, to fill the chamber again with air only at normal temperature and pressure. To avoid bringing the instrument out of the mine the writer has devised a simple automatic arrangement whereby

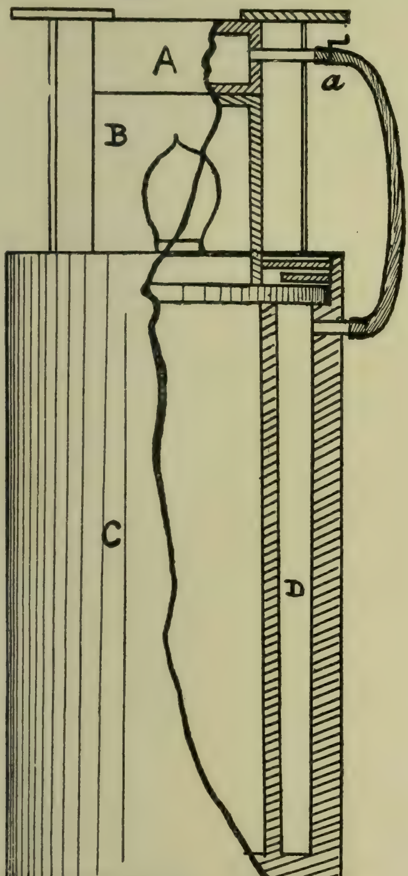


FIG. 4.—Turquand Gas-Tight Non-Spillable Electric Lamp, with Gas-Detecting Apparatus.

A. Atmospheric Chamber.
B. Translucent Lamp-Glass.
C. Battery Case.
D. Compressed Air Chamber.
a. Connexion with Cock between A and D.

compressed air obtained in the apparatus at D is periodically, automatically or otherwise, admitted to the chamber A, which is thus purged ready for the next test.

It will be seen that it is possible by this means to obtain as many tests as the time required for renovating the chamber allows, and that each test will be equally accurate. In a special form, made up for viewers and deputies of mines, the automatic regulation of the air admission is dispensed with, and a hand-operated valve used instead. This arrangement forms a light, compact, and accurate indicator for dangerous mine gases.

The writer has also devised a system, according to which a number of detectors automatically operated and placed where accumulation of gas is anticipated, will give a signal at bank and also swing an indicator notifying what gas the instrument has discovered, and its locality. Possibly the equipment of a mine by the stationary class of instrument would render the hand lamp indicator unnecessary, and be of more service to the engineer responsible for the ventilation.

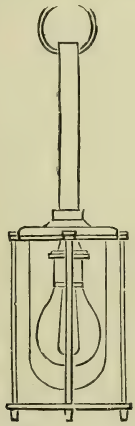


FIG. 5.—Portable Hand-Lamp (Messrs. J. Davis & Son, Derby).

6.—HIGHER VOLTAGE LAMPS CONNECTED TO ELECTRIC SUPPLY.

The advantage of this system in point of candle-power is of course obvious. Disadvantages, however, exist, namely the expense of running mains to the working face of sufficient size to prevent a considerable drop in voltage; also the danger of fire owing to defective insulation and accidental short circuit, and breakage of lamps. Injury through electric shock is, of course, impossible when the voltage is below a certain pressure, and electric

motors operating coal cutters can be wound accordingly.

With the writer's centralized system of gas indication the fire risk is eliminated, as the instruments notify the presence of the obnoxious gases in small quantities long before they can accumulate to a dangerous extent.

Probably the comparative merits of secondary battery lamps and circuit lamps is mainly one of economy of wear and tear, wiring, fitting, and labour. In the one case the hewer carries his own lamp to and fro; in the other case the workings must be wired with due regard to insulation and conductivity.

F. J. T.

The Connexion between Flash-Point of Petroleum and its Qualities as an Illuminant.

By Dr. C. Charitschkoff.

According to special regulations, which are enforced in all civilized countries, petroleum intended for industrial purposes must have a certain minimum flash-point. Unfortunately this criterion is somewhat uncertain, owing to variations in the form of testing apparatus used. For some time the International Petroleum Commission has been considering the establishment of standard methods of testing naphtha and its derivatives, but no definite conclusions on this point have yet been formulated. Meanwhile the publication of conversion-tables, in order to enable the reading of different instruments to be mutually comparable, is much to be desired.

At present the minimum value of 40 degrees C. (according to the Abel-Pensky process) has been proposed, but this has led to many objections on the part of petroleum manufacturers and others who have objected, with some reason, that such an increase in the minimum flash-point would lead to a considerable restriction in the output of commercial petroleum.

In addition I myself believe that the scientific basis on which this proposal is founded is open to some objection. It stands to reason that the determination of the flash-point of a quality of petroleum ought to be considered in connexion with its other qualities. I was recently asked to test a variety of petroleum of low flash-point (probably a so-called falsification product—that is, a sample which was vitiated by the mixture of more volatile fractions). This sample gave very bad results when tested photometrically—burned with a smoky flame and showed a tendency to char; similar qualities have been shown by some varieties of Baku and Grossny "Meteor," which, owing to incomplete distillation possesses a flash-point of about 26°; it was also noticed that after a few hours the illuminating value of such samples showed a marked decrease.

It seems, however, that the flash-point of petroleum should be considered not only as an index of safety, but also as a criterion of its quality as an illuminant and as evidence of its uniformity. I have observed that photometrical tests of samples of petroleum with a flash-point near 30° C. (according to Abel-Pensky process), possess very satisfactory qualities when tested photometrically as well as being quite safe; this limit seems sufficient in the case of light oils, though it might be raised for heavy petroleum.

In short, I am inclined to think that a limit of 30° C. instead of the 40° C. previously suggested, would be a sufficient guarantee as regards safety and quality of petroleum for illuminating purposes. In addition, it is worth noticing that the petroleum which is subjected to transport and carriage for a few months is frequently characterized by a rise in flash-point of 28° to 29° C. (according to Abel-Pensky 30° to 31° C.).

Modern Photometry.

By PROF. H. STRACHE.

(Paper read at the Annual Meeting of the *Verein der Gas- und Wasserfachmännern* in Austria-Hungary, Vienna, May 21, 1909. Owing to restriction of space we have been obliged to abbreviate this paper somewhat and to omit descriptions of some instruments, which have recently been described in this journal.)

THERE is scarcely any technical process which presents such great difficulties as the measurement of light. In making determinations of the illuminating power of sources we are obliged to rely upon the evidence of our senses, and these organs are only adapted for the comparison of the intensities of two impulses of the same nature, and not for direct quantitative estimation. It may be noticed that neither our sense of hearing, smell, nor taste has, up to the present time, been applied for the purpose of measurement and even the sense of feeling is scarcely applicable as a means of quantitative estimation.

All that can be accomplished through the eye is to judge when two adjacent surfaces are illuminated with equal brightness; yet even this is only possible when the illumination is of the same colour in each case. When we seek to compare lights which differ in colour by the aid of our eyes we are immediately confronted by sources of considerable uncertainty. Such measurements depend to some extent upon the peculiarities of the individual; for instance the eyes of one observer may be more sensitive to light of one particular colour than in another. It might be supposed that we could make use of an instrument depending upon the heating, photographical, or chemical effect of radiation. Such instruments are certainly adapted for quantitative measurements, but the results of their use bear no direct relation to the behaviour of the eye, and therefore cannot strictly be applied to obtain information regarding the *illuminating power* of sources.

Another difficulty which has had to be faced in modern photometry has been the measurement of light from lamps of very high intensity. Even the incandescent mantle yielding, say, 100 H.K. cannot be compared with great accuracy against the Hefner lamp on a small photometrical bench because it becomes necessary to bring the Hefner lamp so near the screen of the photometer. The Hefner flame cannot be described as strictly a point source and therefore the inverse square law cannot be rigidly applied when its distance from the photometer is too small. It will readily be understood that this difficulty is of even greater consequence in the case of modern sources of 1,000 or more candle-power and there is need for some method of varying the illumination from such sources according to some definite law.

Several devices have been proposed for this purpose. For instance we may introduce smoked or frosted observing glass, the absorption of this glass being predetermined. Again, we may use a rotating sector—a disc in which there is an opening of prescribed dimensions, placed in the path of the beam of light and rotated at such a speed that no appreciable flicker is visible on the photometer screen.*

An additional refinement in modern photometry has been introduced by the recognition that the intensity of a source of light varies considerably in different directions. It is therefore obvious that a single measurement in any prescribed direction is in itself sufficient, and therefore we must devise some means of obtaining some conception of the distribution of light, both in horizontal and vertical planes. Perhaps the simplest process involves the employment of a reflecting mirror which is moved successively in different positions round the source, so as to

* See Trotter, *Illuminating Engineer*, London, Sept., 1909, p. 585.

reflect the rays in certain directions on the photometer screen. Another method is to use a photometrical screen, which is not retained, as usual, in a vertical plane but is inclined to the photometrical bench at such an angle that the rays from the comparison lamp and the light from the source tested strike it at the same inclination. Yet a third method consists in the adoption of a portable photometer, equipped with a milk-glass plate or a plaster of paris surface, which receives the light in any prescribed direction from the lamp being tested; the measurement being affected by altering the distance away of the comparison light. Such instruments can, of course, be applied to the measurement of light coming in any particular direction; they are, however, usually only satisfactory for determinations in the lower hemisphere.

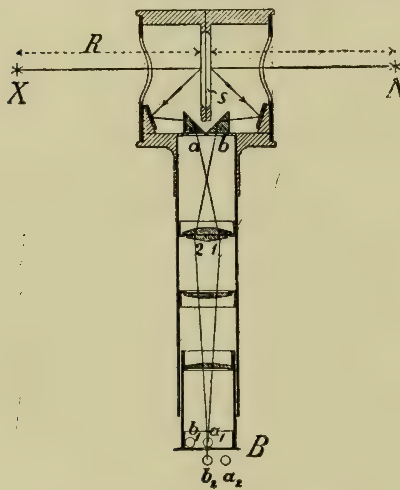


FIG. 1.—Martens Photometer.

Mention must next be made of the type of instruments which have for their object, not the measurement of the intensity of light from a source but rather the illumination which such sources produce in rooms or streets, &c. Such instruments are intended to control the conditions in schools, drawing offices, factories, &c., where good illumination is extremely important, and some check on the conditions in this respect is desirable.

Let me therefore describe a few forms of apparatus which have been designed to answer the above purposes. Reference may first be made to the Lummer-Brodhun photometer (a description of this instrument will be found in page 151 of this journal, Trotter, March, 1909).

Another convenient form of apparatu due to Martens is shown in Fig. 1. The light from the two sources illuminates the two sides of the white screen S. The rays from these two surfaces of the screen are reflected by the aid of mirrors and total reflecting prisms a, b, through the prismatic arrangement, 1, 2, to the eye of the observer, who therefore sees a field of view divided into two halves, illuminated respectively by two surfaces of the photometer screen.*

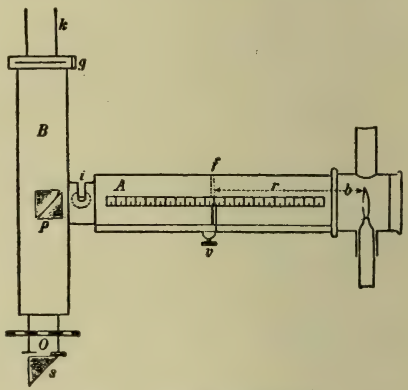


FIG. 2.—Weber Photometer.

A photometer which is particularly well adapted for the measurement of the intensity of very powerful sources of light is the well-known instrument due to Prof. Weber. This is usually applied to the measurements of the brightness of illuminated surfaces; by the use of a milk-glass plate, however, this instrument can be applied equally well to direct measurements. The appearance of the photometer will be understood from Fig. 2. A milk glass plate is moved along the scale *A*, and is illuminated by the comparison light *B*. Its apparent brightness is of course diminished as the distance from the source is increased. A double prism, similar to

* Compare the Bechstein photometer, *Illuminating Engineer*, Vol. I., June, 1908, p. 498.

that employed in the Lummer-Brodhun photometer, reflects the rays of the comparison light into the field of view of the observer at *O*. The other portion of the field of view is illuminated by the rays coming from the milk glass plate *g*, this being brought into equality of brightness by the removal of the plate *f* in the usual way. It is also possible to Fig. 3. In this case the sectors are not themselves put in rotation but are fixed, the effect of revolution being accomplished by optical means. As one sector-disc can be altered in position with respect to the other, it is possible to vary the aperture within wide limits; the extent of opening is indicated on a scale at *t*.

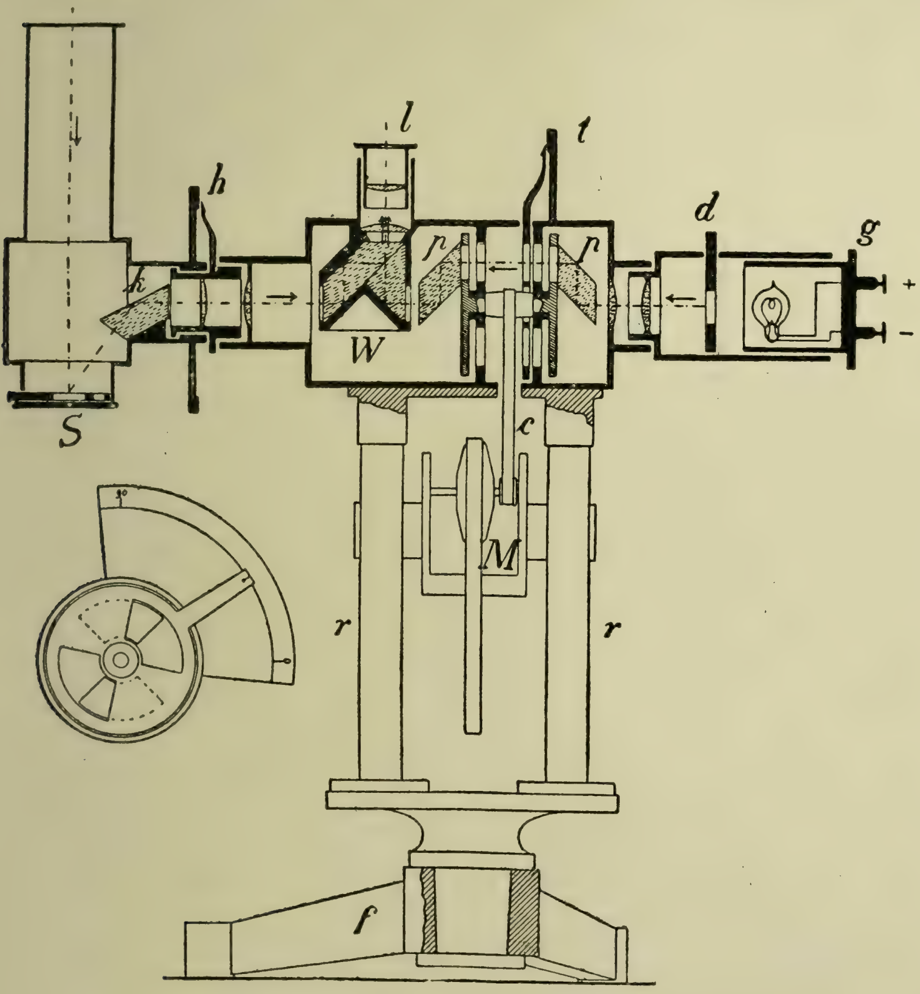


FIG 3.—Brodhun Street Photometer.

remove the plate and observe the illumination of a surface direct, the instrument being merely pointed in any desired direction.

The method of using rotating sectors has been introduced by Brodhun in his street photometer, which is to be seen in

The rays from the comparison source inside the enclosure *g* pass through the two prisms *pp* (between which is placed the adjustable sector), and then on through the optical apparatus constituting the field of view at *W* to the observer's eye at the telescope *l*.

The sector remaining stationary, the beam of light is set in vibration by the rotation of the two prisms *pp*, which are attached to a wheel driven by the electromotor.

During the rotation of the prisms the light is thus alternately extinguished and allowed to pass for successive intervals of time which depend upon the position of the sector ; the speed of rotation must be sufficiently great for no perceptible flicker to be seen in the field of view.

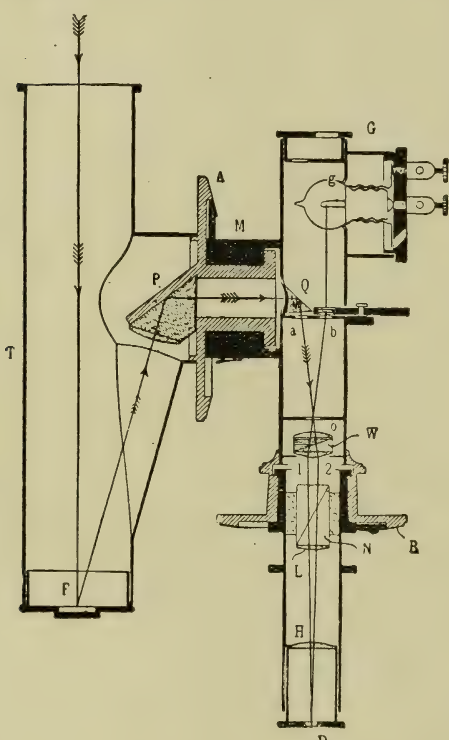


FIG. 4.—Martens Polarisation-Photometer.

The other half of this field of view of the photometer receives light coming from the plaster of paris screen *F*, which is illuminated by the source to be tested.

The rays from the surface *F* are also directed into the field of view by means of the totally reflecting prism *k*, and the arrangement at *w*. The tube *S* being capable of revolution light coming at any specified angle can be measured, this angle being indicated on the scale at *h*.

The weakening of light by means of polarisation apparatus finds example in the Martens Polarisation-photometer (Fig. 4).

The light from the source to be tested is allowed to fall on the white screen *F*, just as in the case of the Lummer-Brodhun photometer. Thence it is diffusely reflected through the totally reflecting prisms *p* and *q* to the polarisation apparatus, consisting of the two Nicols *w* and *n*, and the eye-piece *d*. In the same way light from the comparison source *g* is brought through the two Nicols to *d*. In front of the Nicol at *w* is a prismatic arrangement 1, 2, which divides the field of view into two distinct parts illuminated by rays from *F* and *g* respectively, which are polarised in places at right angles to one another. The two halves of the field of view are brought into equality by rotating the analyzer *N*.

We may next turn to the Ulbricht globe photometer,* which enables the mean spherical candle-power of a source to be determined by means of a single measurement. In gas-photometry, however, care is needed to ensure that the vitiation of the atmosphere in the globe by products of combustion and the alteration in the conditions of ventilation do not influence the light yielded by a source. The Krüss integrating photometer (which does not involve the enclosure of the source in a confined space) is free from this latter objection.

Lastly, I should like to allude to several general questions in connexion with gaslighting which are of considerable importance. I may allude to the experiments of Niesielowski-Gawin on the indirect gaslighting of schoolrooms. These researches led to the conclusion that even in large rooms this method was applicable provided the apparatus was maintained in good order ; lack of uniformity in the mantle, however, might eventually considerably impair the effectiveness of the indirect system ; in addition, a fluctuating gas pressure might lead to the ceiling gradually receiving a

* For description of this instrument see *Illuminating Engineer*, Vol. I. 1908, pp. 274, 553, 1031.

brown sooty deposit. This experimenter also urged that it was inconvenient to be obliged to illuminate the entire room when only a few people were present, and that electric arc-lamps, which could be easily lowered to receive attention, cleaning, &c., were most serviceable.

I should like to point out in this connexion that the brown colouration of the ceiling by the incandescent gaslight is by no means a general experience, and is really only seldom observable; in any case it can hardly result from carbonization, for the bunsen burner admittedly burns smokelessly, and is therefore not noticeably affected in this direction by fluctuations in pressure. The darkening of the ceiling is much more due to the presence of dust in the air, which is sucked up by the stream of hot air and deposited. In dust-free localities no trace of blackening occurs.

The drawback that the entire room must be lighted when only a few people are present applies just as much to electrical methods of inverted lighting.

The remarks regarding the difficulty of attending to gas lamps used for inverted lighting must be admitted to have some justification, and there can be no doubt that the effectiveness of installations of this class soon suffers if constant attention is not paid to the illuminating apparatus.

I should therefore like to suggest, as a question for profitable discussion, the devising of means of enabling such lamps to be easily raised and lowered, and of avoiding the inconvenience involved in attending to such lamps hung high up near the ceiling.

It will be understood from what has been said that the apparatus required in a modern photometrical laboratory is of a complicated and somewhat elaborate character, such as is not likely to be available in any small gasworks or at the disposal of every small manufacturer.

The *Verein*, as will be seen from the contents of the annual report, has therefore recommended the establishing of a testing institution, which will receive the full support of the Technische Hochschule in Vienna and the Education Department.

This institution will be located at the Hochschule, will be equipped with all the needful apparatus, and will undertake all photometrical and other tests at a small fee. For the benefit of small gasworks and industrial concerns, which cannot easily make extensive experiments on their own behalf, the Institution will also be prepared to consider questions in connexion with gas production, testing of fuels, &c., on which assistance may be needed.

It is to be hoped that this Institution will receive warm support, and will prove of very great benefit to the gas industry.

Spectacular Decorations at the Hudson-Fulton Celebration in New York.

The spectacular decorations in New York during the Hudson-Fulton celebration, which has taken place during the time of the recent annual Convention of the Illluminating Engineering Society in that city, have been on an exceptionally large scale.

The following list of lamps employed, which is taken from the monthly publication of the *New York Edison Monthly* for August, will perhaps give some idea of the number.

Building.	Lamps.
Queensboro' Bridge	14,000
Brooklyn Bridge	13,000
Williamsburgh Bridge...	11,000
Manhattan Bridge	11,000
New York City Hall	3,500
Brooklyn Borough Hall	3,600
Queens Borough Hall	1,200
Bronx Borough Hall	2,500
Richmond Borough Hall	2,640
Grant's Tomb	Search lights.
Sailors' and Soldiers' Monument, New York	1,500
Brooklyn Institute of Arts and Sciences ...	7.200
Sailors' and Soldiers' Monument, Brooklyn	1,500
Water Tower	650
Washington Arch, New York	1,500
Riverside Drive Viaduct	5,062
Manhattan Line of Parade, 5th Avenue, from 4th to 59th Streets, through to 8th Avenue, and up to 110th Street ...	25,500
Jamaica Town Hall	900
Flushing Town Hall	900
Total number of Incandescent Lamps ...	107,152

Street Lighting: Fixtures and Illuminants.

By H. Thurston Owens.

(Abstract of Paper presented at the Second Annual Convention of the Illuminating Engineering Society, Philadelphia, October 5th-6th, 1908.)

The author pleads that greater care ought to be bestowed on lamp-posts, and supports for sources used in street-lighting. In the larger cities of the United States the class of street-lighting may be divided into five distinct groups, and each must be handled along separate lines as follows :—

1. Retail business districts.
2. Wholesale business districts.
3. Residence streets in residence districts.
4. Prominent thoroughfares in residence districts.
5. Outlying country roads.

The illuminants which are available for this purpose at the present time are of three types : electric arcs, electric incandescent and mantle lamps, gas or naptha (only those used for regular public lighting being considered). Their development has been briefly as follows :

Gas and Naphtha Lamps.—The oldest and most numerous are the gas-lamps, and the open-flame type, equipped with square lanterns, was until recently that in general use. These have been gradually seperseded by the mantle type, which has become the standard gas-lamp for the lighting of residence streets. Mantle naphtha lamps are equal to those of the gas type in efficiency, and have the great advantage of being self-contained units.

Incandescent Lamps.—The only other small unit is the incandescent electric lamp, which has hitherto been the equivalent of the open flame gas-lamp rather than the mantle type ; but the author considers that the fixture used has not been a credit to either the industry or the municipality. The author, however, anticipates that the more efficient modern sources will be utilized in connexion with fixtures of the type shown in Fig. 2, and located on both sides of the street.

Arc-Lamps.—The well-known open arc-lamp has been replaced by the enclosed type to a considerable extent. Its appearance is not always satisfactory, as will be seen by referring to Fig. 4. This type, which is known as the "Mast Arm," has seen many variations, the idea being to bring the lamp well over the street and beyond the trees.

In the business portions of American cities trees are rarely to be found and the necessity of these long arms dis

Fig. 1.

Fig. 2.

appears, although there is a large number of lamps in use similar to the one shown in Fig. 5. This post could well be combined with the trolley pole, also illustrated, thereby improving not only the appearance but the results as well. Unless arc-lamps are equipped with dense opal globes and hung at least twenty feet high, they should not be located more than three feet beyond the curb line.

Ornamental Lighting.—Street-lighting installations should aim to be orna-

mental, but as this term is now generally used it refers more often to a spectacular installation, and many of these are now to be found somewhat similar to the incandescent lamps with frosted enclosing globes, also illustrated in Fig. 6. For this type of lamp gas is the illuminant used in Europe; while more efficient, it is not likely to become popular here, owing to the attitude of the gas interests toward this feature of the business. Arc-lamps in pairs with dense opal globes are very effective for ornamental lighting, as the white colour is in very pleasing contrast to the yellow from the incandescents upon the surrounding advertising signs. One of the older installations of this type is shown in Fig. 7.

The lighting arrangements for the various districts with the illuminants at hand are summed up as follows:—

Fig. 4.

Fig. 5.

1. *Retail Business Districts.*—In the retail business districts overhead trolleys are usually to be found, and in order that there may be no unnecessary duplication of poles and that the appearance of those in use may be materially improved, a combination trolley and light pole should be used. Another advantage of this system is that there will be a sufficient number of poles at hand ready for use should it be found desirable to increase the number of lamps. Where the underground trolley system has been installed, the types of lamps which can be used successfully vary greatly, and the type is usually determined by the expense involved. The lamps should be hung from 15 ft. to 20 ft. above the street, and should be equipped with frosted or dense opal globes, and when so equipped, have a maximum candle-power of not over 400. The larger the candle-power the higher up it should be placed.

2. *Wholesale Business Districts.*—Arc-lamps will be found the most satisfactory for lighting these districts for two reasons, one being that heavy trucking makes it essential that the posts be as few in number as possible, and therefore large units must be used; and the other is that the excellent reflection obtained from business buildings greatly aids the distribution.

3. *Residence Streets.*—The unit should not be larger than 60 candle-power, placed upon posts, and not more than 12 ft. above the sidewalk, and located upon alternate sides of the street. This means that mantle-gas, mantle-naphtha, or electric incandescent can be used.

Fig. 6.

Fig. 7.

4. *Prominent Thoroughfares in Residence Districts.*—Arc-lamps should be placed upon street intersections at alternate corners, and not more than 300 ft. apart. In case these streets are lined with trees, posts should be of the mast-arm type, the arm being long enough to bring the lamp beyond the line of the trees; and if the traffic is very heavy, additional light should be furnished by means of additional arc-lamps, or by small units. The type of lamp to be used for this additional lighting can only be determined by

each individual case, but as a rule the small unit for local lighting makes the most satisfactory combination.

5. *Outlying Districts.*—Owing to the expense entailed it is impossible to obtain uniform illumination upon outlying thoroughfares. Therefore, it does not greatly matter which type of lamp is selected, provided it is placed on alternate sides of the street. The selection of the illuminant here will depend greatly upon the additional commercial business which may be obtained, which is the principal reason why arcs are so often used for this purpose, not their superiority.

The question of breakage is often brought up as an argument against costly street-lighting fixtures, but, as a matter of fact, as the appearance improves, wilful destruction decreases; and the respect for handsome fixtures will be enhanced if their use for other purposes, such as advertising, be prohibited. The architect's designs of lamp-posts, such as those used to adorn the entrances of buildings, cannot be taken as models for street-lighting. Those who contend that Art Commissions have the ability to cope with the matter would do well to investigate installations having their stamp of approval. Undoubtedly, therefore, it is the business of the illuminating engineer to see that the designs are dignified and artistic as well as efficient.

DISCUSSION.

Mr. C. W. Hare referred to the need for working out a proper general scheme of illumination in a town, and thought the question of proper illumination ought to be dissociated from the pushing of gas or electric interests.

Mr. C. O. Bond drew attention to the great influence of the character of the buildings in a town on the general illumination. In Washington the predominance of white or marble structures had this effect, and the nature of the surface ought to be borne in mind.

The main purpose of lighting was to illuminate the street. This was not always sufficiently realized; 50 per cent of the light from a lamp might, under present circumstances, pass over into a private person's yard, without his paying for it. Mr. Bond believed it was a good plan to hide a light undera bushel —if you got the right kind of bushel. We ought to use some means of keeping all the light in a useful direction.

In conclusion, Mr. Bond objected to the placing of sources very high up, such as some clusters 60 to 70 ft. high in Detroit, as so much light was necessarily wasted in this way.

Mr. V. R. Lansingh thought the ordinary square lamp, having one pane of opal-glass and the others clear, was a good device. This method was used on London Bridge, the opal pane being towards the river, with the result that the boatmen see a light that is not glaring, and a great deal of light is usefully thrown back into the roadway. Of course other devices could be contrived for a similar purpose.

At present many sources used in the streets gave an approximately uniform horizontal intensity, and special arrangements were necessary to see that the illumination was distributed only where it was required.

Dr. A. H. Elliott referred to the incandescent gas-lighting in the streets of Toronto, where 60 candle-power mantles were used, but provided with reflectors, giving the source an effective value of 300 candle-power up and down the streets, but throwing practically no light on to the houses at the side.

Mr. J. E. Woodwell spoke of the value of opal shades in toning down the brightness of illuminants; he thought it was important to direct all light in a downward direction, and to avoid projecting it up and down the street, as this was a strain on the eyes.

In reply Mr. Thurston Owens considered that the incandescent gas-lamp held its own in street-lighting, but not when ornamental appearance was of paramount importance.

In answering further inquiries of Mr. C. W. Hare and others, Mr. Owens stated that the development of ornamental gas-lanterns had progressed rapidly on the Continent, as exemplified by types in use in Paris and Berlin and elsewhere, and there seemed to be an impression that the United States could learn something from methods in this department.

The Theory of Flame and Incandescent Mantle Luminosity.

By W. H. Fulweiler.

(A paper read at a meeting of the Philadelphia Section of the United States Illuminating Engineering Society, January 15, 1909.)

Continued from p. 553.

When a luminous flame is placed in an atmosphere rich in oxygen, made so either by admixture or by raising the pressure, the zone contracts to a slender jet outlining the central core of the flame. The brilliancy increases though the total light decreases owing to the direct oxidation of some of the dydrocarbons to CO_2 and H_2O. On the other hand, when the oxygen is decreased or the atmospheric pressure is lowered, the outer zone expands to furnish a greater surface for exidation, the upper cone is cooled and the intensity is diminished.

Considering how the various causes which tend to increase or diminish the luminosity of the flame, it is found that they may be divided roughly into two classes, those that effect the formation and quantity of the carbon, and those that determine their temperature. Under the first class the effect of diluents may be considered.

Lewes[1] quotes the following ratios that will render an ordinary coal gas flame non-luminous when mixed with the gas prior to ignition :—

Carbon dioxide	1·26 :	1 of gas.
Air	2·27 :	1 of gas.
Nitrogen	2·30 :	1 of gas.
Carbon monoxide ...	5·11 :	1 of gas.
Hydrogen	12·40 :	1 of gas.

The larger ratio is required by the combustible gases that increase the temperature, thereby overcoming to some extent their diluting and cooling action. In the case of the carbon dioxide, as it rises with the illuminants, its action is increased by the fact that it reacts with the carbon at the temperature of the decomposing hydrocarbons forming carbon monoxide.

In general one may consider that the diluents act in two ways, by dilution, and thus decreasing the concentration of the carbon particles per unit of area, and also in small quantities in reducing their temperature in the upper cone while in large quantities this temperature is reduced to such a point that the hydrocarbons are not decomposed—probably when below 1000° C.—and they then burn directly in the outer cone to CO_2 and H_2O with a non-luminous flame.

Comparative measurements have shown the cooling effect in flames rendered non-luminous with air, nitrogen, and carbon dioxide.

With increasing richness of gases in carbon naturally higher ratios of diluents are required to destroy the luminosity, as follows :—

Kind of gas	C.-p. rating	Air	Nitrogen	Carbon dioxide
Coal gas	16·3	2·27	2·30	1·26
Oil gas.........	24·0	5·38	4·20	2·29
Oil gas.........	43·0	7·86	4·71	3·12

Here the action of the oxygen in neutralizing the diluting action of the nitrogen in the air is clearly shown.

That the cooling effect of the diluents is an important factor was shown by Wibel and Heuman who rendered non-luminous flames luminous by restoring to them by preheating the heat absorbed in heating the diluent. Moreover, separating the carbon particles chemically, using chlorine, will render a non-luminous flame luminous.

With flat-flame and argand burners it has been found that by increasing the width of the slit or by the use of larger holes with proper pressure regulation, the duty, or the light evolved per cubic foot of gas burned per hour could be increased. Just what limit may be placed on this extension is not known, but as the pressure must be increased with widening slit, the consumption of gas is increased, so that it would probably be the practical size of the resulting flame. The increased width of slit results in a slightly thicker core of carbon particles, thereby increasing the concentration per unit of area and slightly lengthening the time during which they may be heated, so that they may approach more nearly the temperature of the zone *a b c d*.

The question of the proper burning pressure is another point of importance in realizing the full duty from any burner. With any given size slit, as the pressrue is increased the duty rises to a maximum when the flame is just short of smoking, then falls rapidly with a further increase of pressure.

[1] *Jour. of Gas Lighting*, London, May 3, 1892.

There would appear to be some relation between the velocity with which the gas leaves the tip and its power of expanding by diffusion. As the pressure is increased beyond this critical point an injector action is set up by the sheet of gas drawing air into and mingling with it, thereby destroying the luminosity as noted above, and burning directly into CO_2 and H_2O.

The effect of increasing the concentration of the carbon particles by using hydrocarbons of high carbon density is very important. The following table gives the luminosity in candles of various hydrocarbons when burned—if they could be—at the rate of 5 cu. ft. per hour :

Gas	Formula	C.-p. rating
Methane	CH_4	5·2
Ethane	C_2H_6	35·7
Propane	C_2H_8	56·7
Ethylene	C_2H_4	70·0
Acetylene	C_2H_2	210·0
Benzol	C_6H_6	420·0
Toluol	$C_6H_5CH_3$	741·7
Naphthalene	C_8H_{10}	900·0

Now, however, if one attempts to render a non-luminous flame laminous by means of these hydrocarbons there is produced another set of conditions. It is found that a considerable quantity of the illuminating hydrocarbon must be added before any luminosity is obtained. When working with a hydrogen flame one would have to add the following quantities of the enricher in order to obtain luminosity, which luminosity then increases as further additions are made at the rate shown :—

Gas	To obtain luminosity. Grams per liter	To increase one candle. Grams per liter
Ethylene	0·230	0·0150
Heptane	0·028	0·0115
Benzol	0·018	0·0034
Naphthalene	0·010	0·0020

Irwin,[2] who made these experiments, felt that the efficacy of the carbon atom as an enricher is dependent upon its being joined to another carbon atom, the efficacy increasing with the number of carbon to carbon bonds. He holds that carbon joined to hydrogen has no value as an enricher ; that carbon singly to carbon and then to hydrogen has some value ; that doubly linked carbon is from two to three times as valuable as the single linkage, and trebly linked carbon from seven to nine times as valuable.

Considering now the factors that influence the temperature of the carbon particles in the flame, the size of the outer zone *a b c d* has already been mentioned as influencing the temperature gradient. With argand burners it has

[2] *Jour. of Gas Lighting*, London, July 16, 1895, p. 138.

been found that the intensity may vary widely by using different sizes of chimneys. R. H. Patterson[1] gave the following results, calling the maximum values in each case 100.

Size of chimney. In.	Size of flame. In.	Total candle-power.	Candle-power per unit of area.
None	8·0	66·0	29·3
3	...	98·0	82·0
7×2	4·6	100·0	90·0
9×2	2·75	92·1	97·1
11×2	2·50	84·6	100·0

Thus the increased pull of the chimney brought about a more rapid oxidation, thereby shortening the necessary area of the outer zone *a b c d* and increasing, therefore, the luminosity per unit of area while decreasing the total luminosity by burning more of the hydrocarbons directly to CO_2 and H_2O. This same effect has been observed when using constricted chimneys, but no glass will withstand for any length of time the temperatures involved, which approach that of melting platinum.

If one could protect the carbon from the atmospheric oxygen for a longer period and thus allow it to assume more nearly the flame temperature, or could raise the temperature of the cold—comparatively speaking—inner core of the flame, a higher average temperature of the carbon could be secured in the luminous cone. This result is brought about in the regenerative burners which were first brought to a practical form by Siemens.[2] In these burners the air is preheated by the products of combustion, and its effect is simply to retain in the flame the heat that is otherwise lost by radiation and by conduction to the burner top and the heat required for the incoming gas. In other words, while its advantages are positive as affects the luminosity, it really only neutralizes losses that would otherwise occur.

When these burners begin to realize temperatures that permit of really greatly increased efficiencies, they rapidly deteriorate.

The average output per cubic foot per hour of "16 candle-power" coal gas burned under the best conditions in the various types of burners would be about as follows :—

Regenerative	10·0
Standard argand	3·2
Ordinary argand	2·9
Flat flame No. 7	2·44
Flat flame No. 1	·85

[1] *Jour. of Gas Lighing*, London, June 8, 1880, p. 870.

[2] *Jour. of Gas Lighting*, London, Jan. 13, 1880, p. 60.

INCANDESCENT MANTLES.

It has been seen that in the open flame burners the luminous effect is limited by the inability to bring the radiating body—carbon—to the temperature of the flame. In the incandescent mantle, on the other hand, there is obtained a fixed radiating zone of constant dimensions that may be heated to any practically attainable temperature.

The basic idea of using a fixed incandescent solid was probably originated by Gurney in 1826 when he heated a cylinder of lime in the oxy-hydrogen flame. Drummond, however, perfected the idea, and it now bears his name. Later, buttons of zirconium and magnesium oxide were tried for street lighting in Paris. They were heated by an oxygen coal-gas flame, but were soon abandoned on account of their inconvenience and expense. Talbot[1] in 1835 discovered that calcium oxide in a finely divided state becomes incandescent in the flame of a spirit lamp. Gillard,[2] about 1848, used a basket of platinum gauze to secure a useful light from his non-luminous water-gas plant. The subject seems then to have been dropped until about 1875, when there was a revival of the use of metallic mantles by Palmer in 1876, Lewis 1881, Popps 1882, and Sellon 1886, who made use of platinum generally as the incandescent body. In 1880 Claymond[3] exhibited a basket mantle made of infusible oxides.

In 1885 the Fahnehjelm[4] comb was patented. This was intended, however, for water-gas. In 1886 Welsbach[5] brought out his first mantle. This was very fragile and quite inefficient, as the influence of cerium was not understood until 1892 when the 99 her cent thorium and 1 per cent mixture was brought out. This mixture really put the mantle technically on a commercial basis, the other difficulties being entirely mechanical.

A curious phase of this question is presented by the inventor running probably quite wide of the mark in his explanation of the mantle's action; a parallel case was Edison's bad guess at the true explanation of the reactions involved in the improved storage battery he brought out seven or eight years ago.

There has been a great deal of investigation done on the cause of the mantle's luminosity, and a good deal of lofty speculation has been indulged in.

Among the earlier theories were:—Lewes'[1] who suggested a gradual change in crystalline structure in the mantle. Drossbach[2] invested the mantle earths with the property of a special resonance to the light vibrations.

Killings[3] ascribed the effect to a double state of oxidation with the cerium acting as a catalytic body. Moschelles[4] and Bunte[5] also subscribed to the catalytic theory.

Bunte[6] had heated prisms of the oxides in an electric furnace, and on comparing their radiation with that from similarly heated pieces of carbon and magnesia, observed very little difference in their radiating effect. He seems to have overlooked Kirchhoff's laws, as in this case the radiations must have been purely black radiation.

Swinton[7] heated the oxides in a cathode tube, and found that while the 99 per cent thorium and 1 per cent cerium mixture heated and cooled more rapdily than the others, yet there was little difference in their radiating effect.

Le Chatelier and Boudouard,[8] in 1896, noted that the mantle acted as a "coloured body"—that is, not as an absolutely black body as Kirchhoff defined it—but they assumed that as its total energy was less than that from a black body, and as it was concentrated in the visible portion of the spectrum, the mantle would for the shorter wave lengths give a higher black body temperature than its true temperature. This result was of course in opposition to Kirchhoff's first principle.

Killing[9] noted that there were a number of the heavy metals that would excite the great increase in luminous radiation in the thoria mantle, among them platinum, a single drop of the solution increasing the luminosity about 1,000 per cent. He felt that this quantity was too small to account for the observed phenomenon. However, he called attention to the fact that the thoria, on account of its large surface and low specific heat, could rapidly acquire a high temperature.

Bunte had calculated, however, that the actual amount of cerium in a mantle

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[1] *Phil. Mag.*, 3, 1835, p. 114.

[2] *Jour. of Gas Lighting*, London, Nov. 11, 1850, p. 318.

[3] *Jour. of Gas Lighting*, London, Dec. 13, 1887, p. 1002.

[4] *Jour. of Gas Lighting*, London, July 6, 1886, p. 22.

Vienna Pharma. Centieche, 2, 1886.

[1] *Jour. of Gas Lighting*, London, May 19, 1896, p. 1104.

[2] *Jour. für Gasbel*, 11, 1897, p. 174, and 2 1898, p. 352.

[3] *Jour. für Gasbel*, 21, 1897, p. 339.

[4] *Zeit. für Beleuchtungwesch*, 11, 189

[5] *Rev. deutsch. Chem. Gess.*, 1896.

[6] *Ber. d. Chem. Gess.*, 31, 1898, p. 7

[7] *Proc. Royal Soc.*, 1899.

[8] *Compt. rendus*, 126, 1898, p. 1861

[9] *Jour. fur Gasbel*, 21, 1897, p. 339.

was some forty times the weight of the luminescent carbon particles in a flat flame, so that Killing's objection did not necessarily hold. He still felt, however, that as the thoria-cerium mixture would lower the temperature of ignition of a hydrogen-oxygen mixture by some 300 C. there must be some catalytic action, and that the cerium, thus finely divided, focussed the temperature of the flame on itself, thus raising it to an extremely high value.

In 1900 Nernst and Bose[1] heated electrically the mantle earths in the form of thin rods, and compared their radiation in the different wave lengths with that from an ordinary mantle heated by a flame. They found very little difference throughout the spectrum. The maximum variations, about 3 per cent, were at the two ends. They felt that the effect was due to selective radiation; that as the mantle emitted only a few red rays it could then come to a very high temperature.

It is believed that much of the misconception regarding the phenomenon has been due to inaccurate knowledge of the temperature conditions, and an endeavour to find theories to fit erroneous observations. This result was due to lack of knowledge regarding the proper handling of the small thermo-couples that were used in making the temperature measurements.

White and Travers,[2] in 1902, secured results of high probable accuracy by using several couples of different sizes and making observations at the same point with each one, subsequently plotting the curve of temperatures, observed against the cross-sections of the couple used and extrapolating to zero cross-section. Working in this manner, they found that the thoria-ceria mantle was at a lower temperature than the pure thoria mantle, and that in general the mantles were about 130° C. below the temperature of the flame.

These are the results one should have expected from the theory and the knowledge of the relative emissive and absorbative properties of cerium and thorium.

They felt that the ceria was in solid solution in the thoria when it was most efficient.

Féry,[3] in 1902, investigated the influence of ceria in the mantle, and held that from its very high emissive power it could not keep warm, but that when it was in a very fine state of subdivision, as it is in the mantle, it assumed the temperature

[1] *Beeckes Phys. Zeit.*, 26, 1900, p. 289.
[2] *Jour. Soc. Chem. Ind.*, 15, 1902, p. 1012.
[3] *Ann. de Chem. et de Phys.*, 27, 1902, p. 433.

of the thoria, and on account of its selective radiation was a very efficient radiator.

Killing[1] made some experiments with thoria and thoria-cerium mantles in a Junkers calorimeter, and found that 1 per ecnt of ceria increased the radiation by 13·9 per cent. He checked this value, using delicate black bulb thermometers, and obtained 14·0 per cent.

Bunte[2] went over the subject again. He renounced the catalytic theory, arguing that the mantle was colder than the flame, and, in general, came to Féry's conclusions. He showed from measurements of temperature and luminosity made at different zones on the mantle's surface that there varied much, as one should have expected from the Wien-Planck law.

Smidt, working in conjunction with him, investigated the distribution of the energy from a thorium mantle containing varying percentages of cerium.

He found that as the cerium increased up to ·5 per cent the radiation in the blue increased as the temperature rose, the illuminating power increasing. Above ·5 per cent of cerium, the red rays began to increase, and with them the luminosity, until it reached a maximum at 1·5 per cent. Beyond this point the radiation in the red increased very rapidly and the luminosity decreased. St. John[3] did some work on the spectrum of the mantle, as did Kruss,[4] and lately Rubens[5] studied the distribution of the energy of a mantle and compared it with that from a Bunsen flame, and also to an absolutely black body heated to the same temperature—1800° C. abs.

He gives the following figures showing the ratios of the radiation at different wave lengths with that of a black body :—

Wave length in μ.	Ratio.
0·45	0·86
0·50	0·72
0·55	0·49
0·60	0·24
0·70	0·062

He showed that in general the mantle followed the Bunsen burner up to the long wave lengths $5{\cdot}0\mu$ and was probably transparent to the radiations from it. All of their work has shown the influence of small quantities of cerium in affecting the "coloured" character of the thoria.

In 1903 St. Clair Deville[6] agreed with

[1] *Jour. für Gasbel*, 23, 1903, p. 445.
[2] *Ber. Inter. Cong. de Chemie*, Berlin, May, 1903.
[3] *Wied. Ann. Phys. Chem.*, 56, 1895, p. 333.
[4] *Jour. für Gasbel*, 27, 1896, p. 425.
[5] *Jour. für Gasbel*, 2, 1906, p. 25.
[6] *Compt. rendus, 1er Int. Cong. de Phot.*, 1903.

Féry and considered that the phenomenon was simply a case of a selective radiant at high temperature.

Thus the complex theory was finally reduced to the fact that thoria, coming from its physical characteristics to a high temperature and under the influence of the ceria which it probably holds in solid solution acts as a "coloured" body having a high selective radiation in the shorter wave lengths of the visible spectrum.

(*To be continued.*)

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* Some Publications Recently Received.

Annuaire Paul Durand: Annuaire general des Industries de l'Eclairage, du Chauffage, et de la Force Motrice par la Gaz et l'Electricitè (Madame P. Durand, 12, Rue Fontaine, Paris).—An annual publication by the proprietor of *Le Gaz*, dealing in a comprehensive manner with the gas and electrical industries. This is another example of those serviceable publications in which statistics referring to both methods of illumination are tabulated side by side.

Annuaire International de l'Acetylene. Edited by MM. R. Granjon and P. Rosemberg. (Paris, 104, Boulevard de Clichy, price 2 fr. 50).—The annual for 1909 again contains a varied and complete series of data relating to the acetylene industry and the uses of acetylene both for lighting and for special purposes, notably oxy-acetylene welding, &c. Like its predecessors the present volume should be found of considerable interest to those concerned with acetylene lighting in all its branches.

A Pocket-Book of Electrical Rules and Tables, by Prof. A. Jamieson and J. Munro, 1908. (Messrs. Charles Griffin & Co., Ltd., Exeter Street, Strand, London, W.C., 8*s*. 6*d*.).—This is the nineteenth edition of the well-known little volume on electrical rules and tables. We note that the present edition again contains exhaustive data on electrical matters in an easily accessible form. A feature of special interest to our readers is the section dealing with electric lighting and illumination, which has been revised and brought up to date.

Bricht über die Versammlung des Verbandes Deutscher Elektrotechniker, 1909.—The official account of the annual meeting of the *Verband* held at Cologne this year. Besides referring to the deliberations of the various committees, &c., several papers dealing with electrical lighting by Prof. Bermbach, Libesney, &c., are reproduced.

Optische Untersuchung schneller und Fouriersche Analyse periodischer Druckschwankungen, by E. F. Martens (Reprint from the *Proceedings* of the Deutsche Physikalische Gessellschaft). (Fried. Vieweg und Sohn, Braunschweig, Germany).

Uber die Fortpflanzungsgeschwindigkeit der von einem Poulson- Lichtbogen ausgesandten kurzwelligen Schallstrahlen. By E. Dieckmann, from *Annalen der Physik.* (J. A. Barth, Leipsic).

Fortschritte der Strassenbeleuchtung. By Dr. L. Blcch. Reprinted from the *Elektrotechnische Zeitschrift*, 1909, vol. 30, pp. 31 to 32.

Among other valued publications received during the past month we may mention: *Arkiv für Matematik, Astronomi och Fysik* (*Stockholm*), *American Chemical Journal, Proceedings of the American Institute of Electrical Engineers, Proceedings of the American Physical Society, Transactions of the Institution of Civil Engineers* (*London*), *Empire Review, Transactions of the Illuminating Engineering Society* (*United States*), *Papers read before the Iron and Steel Institute* (*London*), *&c.*

We have also received the programme and announcements of the educational work at the Northampton Institute (Clerkenwell, London, E.C.) for the coming session. Among the many spheres of activity of this institution it is again interesting to observe that a special course of study, including both lectures and practical work dealing with illumination is supervised by Dr. C. V. Drysdale. Special attention is paid to the subject of photometry and the scientific principles underlying efficient light production. Intending students may note that enrolment commences on September 13th and classes on September 27th.

* To some of these publications we mean to refer in detail on another occasion.

London's Electric Light Standards.

In a recent number of *The Builder* (August 21, 1909) attention is drawn to the various widely differing types of electric light standards which are now to be found in the streets of London, and the author, in reviewing their æsthetic qualities, comes to the conclusion that most are more of less defective from the artistic standpoint.

Figs. 1 and 2, for the use of which we are indebted to the courtesy of the editor of the journal named above, represent two of the types which are commented upon in some detail.

Fig. 1 refers to the type of standard along the Thames Embankment, and it is remarked that the details, particularly of the lower parts, are evidently done by an able modeller—are, indeed, probably better than the dimeneions of the sketch enables one to observe. However, it is contended that nicety of design in detail is lost when applied to such structural peculiarities as those shown at A and B, " in which the eye looks at an extra thick bent pipe capable of supporting the weight of scores of lamps, but about whose quality of cohesive metal fibre the designer was so nervously doubtful that, to save a possible subsequent catastrophe, he tied it up with a tensile rod to the main post." In fact, it is suggested, no degree of ornament can help out the weak constructive lines at A and B.

Fig. 2, it is explained, occurs near the Town Hall at Battersea, and our contemporary is extremely averse to the lines of design at the top of the post ; this is the more felt on account of its proximity to " Mr. Mountford's admirable Town Hall."

One direction of design to which our contemporary takes exception is the tendency to begin with an assumed architectural regular column having a sham capital at top. On this is planted a bent rod or bracket, both objects apparently having no connexion with the staff below by which they are really maintained in position. The feeling conveyed is therefore that there is no adequare means of support and that the rod or bracket would snap away or topple off at the capital.

Having referred to our contemporary's criticisms of existing models, we may, perhaps, refer to several which are given as indications of lines on which designs might proceed in the future, with more successful results. Many of the old village sign-posts of the past, it is suggested, might well serve as a model of fittings for the illuminants of the present. Fig 3, for instance, is really the well-known village sign-post at the Duke's Head at Leatherhead with practically little more change than that involved in the substitution of the electrical lamp for the sign board and an iron post for the wooden one.

Fig. 4, which is a rough sketch of one of the new standards round the Queen Victoria Memorial, also meets with approval and the treatment of the head of these is regarded as being in a true spirit of constructional design.

In addition it is pointed out that many of the standards being erected are situated immediately adjacent to buildings of considerable architectural distinction, with which they are naturally in many cases quite out of harmony, being, apart from quality of design, essentially modern in their treatment. It is possible therefore, that, once this point is realized something might perhape be done in the future to secure more perfect conditions in this respect.

The Quality of Black Surfaces used for the Measurement of Radiation.

A recent contribution in *Comptes Rendus* (C. Féry 148, p. 177, March 22nd, 1909) raises a very interesting point in connexion with measurements of radiation by means of thermal couples and the bolometer. It is pointed out that it is not only necessary, when studying the radiation from a black body, to secure that this body approaches very nearly the theoretical quality of absorbing absolutely all the radiation which falls upon it. It is also essential that the surface by which such radiation is absorbed and measured must be truly black. If such a surface exercises selective radiation it naturally tends to favour the measurement of energy of certain wavelengths and suppresses others, and naturally this interferes with the perception of the true law. For instance, it was found that couples coated with platinum black behave in a distinct manner from those which are smoked on account of the different quality of the surface.

It is anticipated that this result will render necessary the predetermination of certain optical constants and laws of radiation which were carried out without due attention been paid to the quality of the receiver.

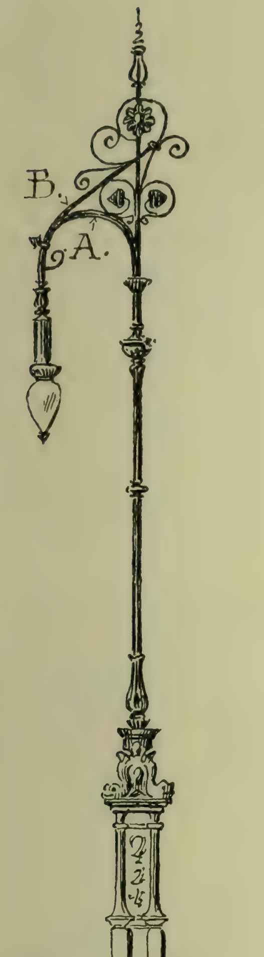


FIG. 1.—Type of Electric Standard used along Thames Embankment, London.

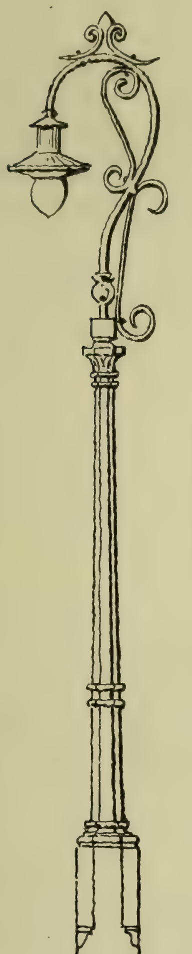


FIG. 2. — Type of Electric Light Standard near Town Hall, Battersea.

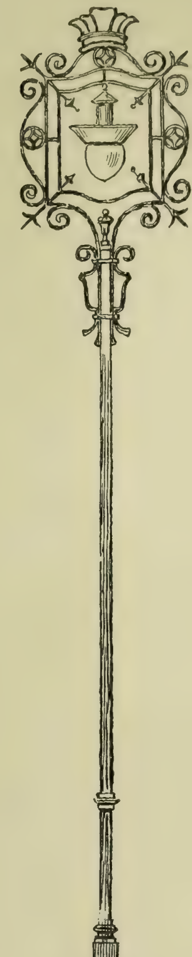


FIG. 3.—Suggested Model based on Duke's Head Sign at Leatherhead.

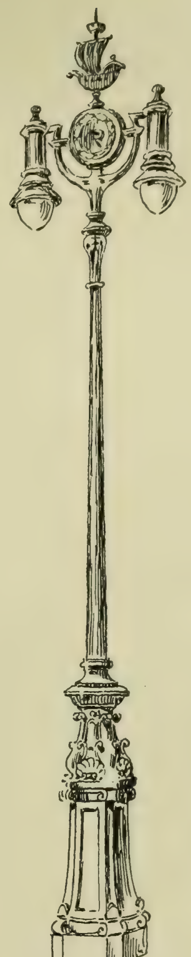


FIG. 4. — Type of Standard near Queen Victoria Memorial, London.

The Importance of Illumination in Hospitals.

A WRITER in a recent number of the *Evening News* (Sept. 24th, 1909), in contrasting the conditions in the new hospital at Homerton, just opened by the City of London Guardians, with those prevalent in many hospitals and workhouses of fifty years ago, makes special mention of the improved illumination.

On this point he says: "I know of no greater contrast in the two methods of treating the poor. The barrack-like workhouse, with its badly lighted corridors, along which one finds one's way by the help of gas jets, and peeps into day rooms and wards where the human wreckage that belongs to the city is housed, the boarded floors, the coloured brick walls, and general lack of brightness, in spite of toning up at the hands of the painter, all are in striking contrast to the homely warm-looking wards and day rooms, where the sick of the city are to be nursed back to health, or comforted to the end of their days."

An Integrating Photometer.

By Dr. H. Krüss.

(Abstracted from the *Journal für Gasbeleuchtung*, July 4th, 1908.)

The Ulbricht globe is, in the true sense of the word, an integrating photometer, in that it sums up the intensity of the light from a source in all directions. Unfortunately, a globe of sufficient dimensions to be used in connexion with sources equipped with shades, &c., occupies a vast amount of space.

In the present article Dr. Krüss describes some of the integrating mirror photometers that have been devised, and explains the details of an instrument of this class recently designed by himself. In all such instruments a series of mirrors, inclined in such a way as to cast the energy from the source of light in a large number of directions on the photometer-screen, are employed, thus forming what is virtually a reflecting vertical semicircle, with the source at its centre. Such mirrors are usually spaced at intervals of 10 or 15 degrees. Instruments of this type have been designed, among others, by Brodhun, Blondel, and Matthews.

It may be observed, however, that in all such cases we must either assume the source of light to emit rays symmetrically in a horizontal plane, or we must take the mean of a number of results obtained by rotating the source about a vertical axis. Another point to be remembered is that the mean spherical candle-power is given by the expression $\frac{1}{2}\int I_\theta \cos. \theta. d\theta.$, and therefore we must, in our automatic integrating apparatus, in some way introduce the factor "cos. θ."

In the Matthews photometer this was accomplished by the fact that the rays from the different individual mirrors struck the photometer screen placed at the centre of the circle at different angles, the intensity being thus proportional to "cos θ," according to Lambert's law. This method, however, necessitates keeping the photometer in the correct position and moving only the comparison-light; besides, Lambert's law does not apply rigidly at oblique inclinations, and hence a further correction was necessary, introduced either by slightly altering the distance away of the mirrors, or by the aid of smoked glasses.

Blondel adopted the ingenious device of enclosing the whole arrangement inside a globe, equipped with slits of length proportional to cos θ, at the correct angular distances from the equator. The whole globe was then put in rapid rotation about a vertical axis. Apart from its expense and complexity, however, this device gives rise to a very considerable loss of light.

The modification of the Matthews integrator, devised by Krüss, is shown in Fig. 1.

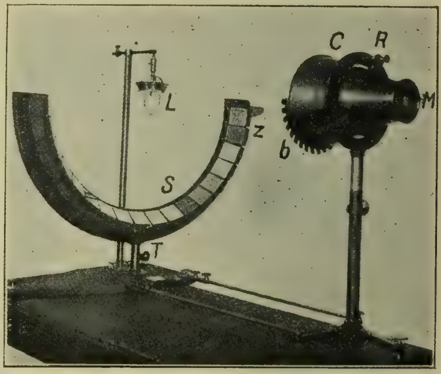


Fig. 1.

The source of light L is placed at the centre of the semi-circle S. By fitting the conical plug Z into the holder T, the circle can be made to assume a horizontal position. If necessary a complete circle may also be used. The beams of light from the mirrors fall upon a corresponding set of lenses, shown, protected by suitable screens, at C, and these lenses, again, concentrate the light on the plate of opal glass at M. This opal glass may itself become a luminous source, the intensity of which is measured in the usual way. The "cos θ" factor may now be very easily introduced by varying the diameter of a stop b placed in front of each lens, as shown in Fig. 2.

This arrangement, however, is not quite satisfactory. In order that the glass plate M may really act as a source, it must be composed of very dense glass, and this absorbs a great deal of light. It would be better, therefore, to make this plate an integral portion of the field of view of a portable Weber photometer. Now, with the optical arrangement shown in Fig. 2, a series of bright

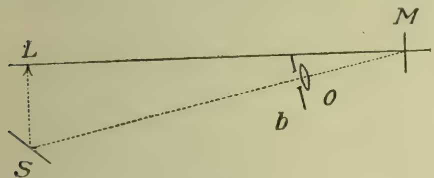


FIG. 2.

images of the source of light, and hence also an unevenly illuminated field, would be obtained.

The author, therefore, recommends the arrangement shown in Fig. 3, where a second lens O forms an image of the aperture *b*. The lenses are also so chosen and adjusted that a series of similar images of this aperture are superimposed upon one another on the screen M, and a uniform field is obtained.

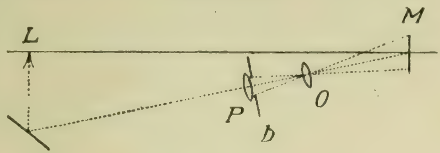


FIG. 3.

It may be observed that the cone C on which the series of lenses are mounted may be rotated about a horizontal axis, and that by covering up all except one, the intensity of the ray in any individual direction may be measured. The constant of the instrument is obtained in the usual way by testing some source the mean spherical candle-power of which has been accurately predetermined.

Phosphorescence and Luminescence.

THE possible utilization of phosphorescent materials as a means of light-production is interesting, but the fundamental principles of the subject are still very imperfectly understood.

A recent series of researches, published by Dr. E. L. Nichols and E. Merrit in *The Physical Review*, indicates very clearly the complexity of the phenomena on which phosphorescence seems actually to depend.

It can only be supposed that when light is allowed to play on a phosphorescent substance, some molecular rearrangement takes place, the electrons only gradually returning to their normal condition subsequently, and furnishing light while doing so. The "decay-curves," showing the nature of the dying away of this intensity, and the spectra of the light emitted, are two valuable means of studying these effects.

The authors describe some observations on Sidot blende, in which the general shape of the curve is due to the decay of the green band; substances, however, may yield spectra having several bands which are of different intensity, and decay at different rates; this suggests the presence of several distinct internal iönic systems independent of each other, generating radiation of different frequency, but all contributing to the resultant light. A very interesting effect is the apparent influence of infra-red rays, which seems to hasten the decay of such systems.

It has been suggested that phosphorescent effects only occur when the spectrum contains two distinct bands or more, but the authors think this is open to question.

It seems to be definitely believed that luminescent and phosphorescent effects only occur in so-called "solid solutions." A *perfectly pure* substance never exhibits these phenomena. Naturally, therefore, the uniformity of distribution of active material in the mass studied may be supposed to affect the results, and an increase in temperature may hasten or retard the decay.

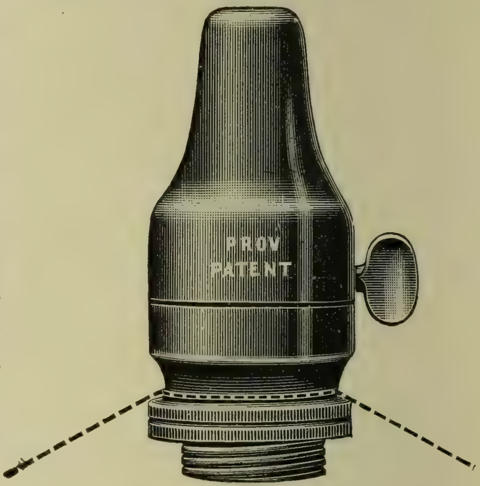
In summing up the situation the authors remark: "The present difficulty is not so much in accounting for observed facts, as in discriminating between different hypotheses that are at present equally plausible." Yet the study of these obscure facts may have great consequences in the future.

TRADE NOTES.

[At the request of many of our readers we are extending the space devoted to Trade Notes, and are open to receive for publication particulars of new developments in lamps, fixtures, and all kinds of apparatus connected with illumination.

The contents of these pages, in which is included information supplied by the makers, will, it is hoped, serve as a guide to recent commercial developments, and we welcome the receipt of all *bona fide* information relating thereto.]

The "Guardian" Safe Pendant Lamp Holder.



In a recent number of this journal attention was drawn to the "Guardian" hand lamps, specially constructed with a view to safety from electrical shock and to meet the Home Office requirements.

The same firm (**Messrs. Ward & Goldstone**, Sampson Works, Salford, Manchester) now send us particulars of their pendant lamp holder, which they state to be constructed on similar principles. It will be seen from the illustration that this consists essentially of an insulating cover completely enclosing the metal case of the holder and cap of lamp, which is claimed to remove the necessity for any earthing wire.

In addition a rubber ring grips the flexible cord and serves to prevent any possibility of rupture.

Low Prices for Carbon Filament Lamps.

We have received from **Messrs. Siemens Brothers**, Dynamo Works, Limited, of Tyssen Street, Dalston, N., their latest catalogue of Carbon Filament Lamps. This list is very complete, and illustrates many types of lamps as stocked by the firm. It may be noted that prices have been reduced throughout, and it is anticipated that the reductions in prices of radiator lamps, of lamp lacquers, and obscuring varnishes will be particularly welcome.

We have also received from the fittings department of the same firm, a copy of their latest "Tantalum" Arc List 29B, illustrating numerous new designs of the patent wireless cluster fittings supplied by this firm, which are of particular interest to shopkeepers.

We understand that **Messrs. Siemens Brothers** are willing to send quantities of these lists, printed with the name and address of the electrical contractor, free on receipt of application.

Ideal Candle-Fitting.

The Electrical Co., Ltd. (Charing Cross Road, London) sends us particulars of the improved "Ideal" candle-fitting, which utilizes a metallic filament, but is claimed to imitate a wax candle very closely; special attention is called to a method of illuminating a portion of the porcelain tube which is said to intensify the resemblance.

The same firm also send us particulars of the most recent prices of Aegma metallic filament lamps; these are now made for pressures varying from 20 to 260 volts, and for candle-powers from 5 to 400. Miniature Aegma lamps for use with portable accumulators are also available.

Change of Address of the Holophane Glass Company.

We are requested to announce that the **Holophane Glass Company** have now secured more extensive premises at 12, Carteret Street, Westminster, London, and that all business will in future be transacted at this address.

A New Device for Use with Metallic Filament Lamp Holders.

The accompanying illustration shows the "lamp-holder husk," a device regarding which we have received particulars from the **Armorduct Company,** Farringdon Avenue, E.C. The "husk" consists essentially of a metal sleeve intended to cover the lamp caps of metallic filament lamps as shown in the illustration.

When metallic filament lamps are inserted in existing holders it is frequently found that, on account of the large bulbs required, the base of the lamp and the cap appear unsightly. This appearance is improved by placing the husk over the junction and covering up the base of the lamp. The husk is stated to be specially suitable for use with frosted lamps, and is supplied in bright or dull brass or oxidized, or in any special finish to match existing fittings or decorations.

Gold Mirrors for Searchlight.

The recent Royal Automobile Club tests on motor-car headlights have brought prominently before the notice of motorists and the public generally, the importance of road illumination from the point of view of all users of the road. The following information, referring to types of "Gold Mirrors" for searchlights, which we have received from the **Refractor Syndicate, Ltd.,** (82, Victoria Street, Westminster, London) may therefore be of interest to readers of these columns.

There has been considerable outcry against the use of powerful headlights showing a white blinding "glare" or "dazzle." It had previously been taken for granted that the whiter and the more powerful the light, the more perfect illumination obtained. This, however, is claimed to be by no meane the case, and it is suggested that the rays of low refrangibility, *i.e.*, the red and yellow rays, are far less absorbed by the atmosphere than the violet rays. As an example of this the comparative penetrative power of gas and of the electric arc in a fog, is quoted, the high-candle-powered arc lamp being visible at a shorter distance than the gas light. Again the red colour exhibited by the sun at its setting is also explained on the ground that the violet rays are largely absorbed by the greater thickness of atmosphere which must be penetrated by the sun's rays.

A long series of experiments have been made with glass mirrors coated with gold instead of the usual silver deposit. The resulting beam of light is stated to be practically devoid of the blue and violet rays of the spectrum, being composed of red, yellow, and green rays only. At the same time its range or penetrative power is not reduced, and, by the elimination of the violet rays, the dazzling effect is claimed to be greatly reduced.

We are also informed that in the recent Royal Automobile Club tests the only three lamps fitted with gold reflectors secured the first three places for maximum distance from lamp without dazzle. Again, for Naval projector work it is found that a torpedo boat on a rainy or foggy night can be more clearly seen with a gold than with a silver mirror projector. The objects illuminated stand out more prominently and there is truer colour rendering.

We understand that the gold mirrors are being supplied to the principal lamp makers by the Reflector Syndicate Ltd., of 82, Victoria Street, Westminster, S.W., who hold the patents for the process.

Gral-Arc Fittings.

We have received from the **Armorduct Company** (Farringdon Avenue, London, E.C.) some particulars of the Gral-arc fittings for interior and exterior lighting, some examples of which will be seen in Fig. 1 and Fig. 2.

These fittings are specially intended for use with Tungsten lamps of various capacities. They are supplied in either black enamel or art-copper finish, and are considered specially suitable for the lighting of large shops, restaurants, public buildings, &c. Various patterns of globes are available, and the interior reflectors are so arranged that from one to five lamps can be utilized, either in the form of small units in series or large units in parallel.

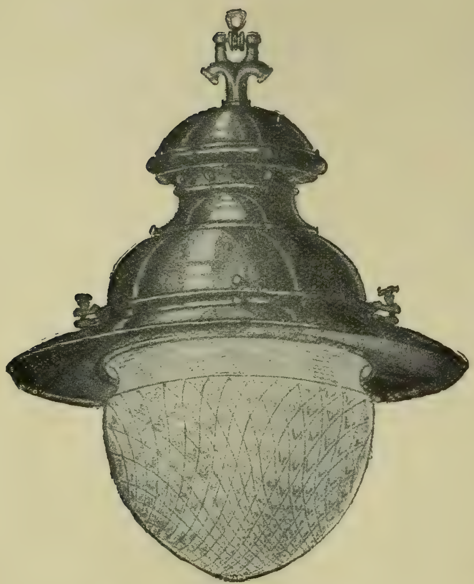


Fig. 1.—"Regent" Fitting.

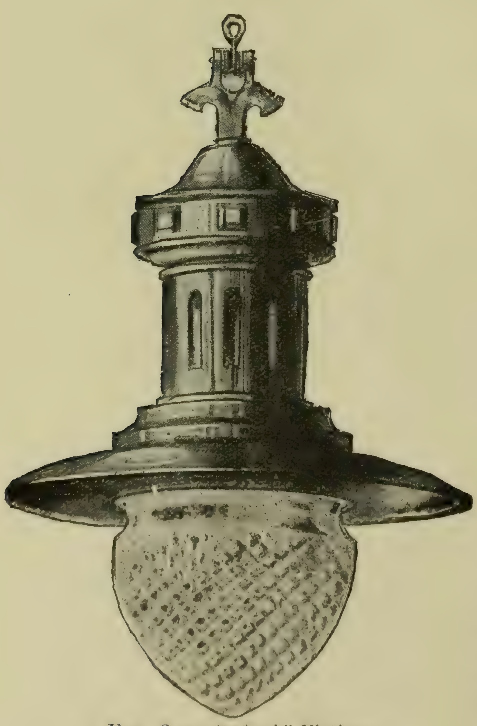


Fig. 2.—"Oxford" Fitting.

Westminster Electrical Testing Laboratory.

The Westminster Electrical Testing Laboratory (York Street, Westminster, London) send us a copy of their prospectus and scale of fees for testing work. Besides undertaking general electrical testing, the laboratory makes a special study of photometry.

Okanite & Manson Insulating Tape.

We have received from **Messrs. William Geiple & Co.** (Vulcan Works, St. Thomas's Street, London, S.E.) particulars and samples of the tape named above, which is claimed to have exceptionally high insulating values, and to be applied in a very simple manner in repairing joints and cables. Some particulars are also given of tests on the material by Prof. J. A. Fleming, of University College, which appeared to have led to very satisfactory results.

New Edition of the Universal Electrical Directory.

We are informed that the 1910 edition of the **Universal Electrical Directory** is in course of preparation for its twenty-ninth annual issue on January next. Any errors in existing notices should therefore be rectified, and any additional matter sent in as early as possible. Full particulars can be obtained from the publishers, H. Alabaster, Gatehouse & Co., 4, Ludgate Hill, London, E.C.

Review of the Technical Press.

ILLUMINATION AND PHOTOMETRY.

MENTION may be first made of the final publication in the *Journal* of the Society of Arts of the remaining Cantor Lectures of **Mr. L. Gaster,** previously alluded to in this review.

Several articles have appeared in the last month dealing with physiological aspects of illumination, including papers before the Illuminating Engineering Society (New York). For instance, **Prof. S. W. Ashe** discusses the effect of light of different colours on the pupil orifice of the eye; he shows that this varies throughout the spectrum very much in the same manner as does the luminosity of the different colours. However, for light of a given intensity, a somewhat wider aperture was obtained for the *red* end of the spectrum. He also describes some experiments of visual acuity which suggest that sharper outlines were obtained in the case of detail illuminated by the green end of the spectrum. A paper by **Dr. Pyle** discusses the chief defects in vision and methods of testing them, and insists upon a close connexion between the state of the eyes and general bodily health.

Several articles dealing with the ULTRA-VIOLET RAYS and intrinsic brilliancy may be mentioned. Thus **J. A. Grand,** in France, gives a summary of the work of Dr. Schanz and Stockhausen. Another note in a French journal mentions the somewhat novel method of studying the fatiguing effect of different illuminants, namely by observing the number of times which the eye winks per minute in each case (*Jour. de l'Union des Proprietaires d'Appareils à Acetylene*, July-August).

Recent editorials in *The Electrical World* of New York are also concerned mainly with such subjects as the effect of ULTRA-VIOLET LIGHT, HETEROCHROMATIC PHOTOMETRY, and the LUMINOUS EQUIVALENT OF RADIATION—all matters having a distinctly physiological basis. **A. J. Marshall** in the September number of *Light* continues his article on HYGIENE OF THE EYES; on the present occasion he refers in some detail to his theory that light symbols on dark background are preferable in printing.

Turning next to articles on photometrical matters we may mention that by **E. L. Elliott** in which he describes, in a popular fashion, the action of the Ives Colorimeter (*Illum. Eng.*, New York, Sept.). *The Gas World* (Sept. 4th) reproduces in abstract a rather striking article by **W. Wissmann,** who draws attention to the great need for some standard method of specifying the light given out by incandescent gas lamps. He points out that the usual terminology is very loose, and draws attention to the recently published suggestions of the German Institution of Electrical Engineers on this point, which will probably be adopted, in a somewhat modified form, by the gas industry in Germany.

Mention may next be made of several papers which deal with FIXTURES from the artistic standpoint, for instance, that by **E. L. Elliott** of *The Illuminating Engineer*, New York, for September. A somewhat elaborate article giving a series of original designs for electric lighting fixtures by **G. Horvath** will be found in *Illumination* for August.

Lastly, reference may be made to an interesting article in *The Journal of Gas Lighting* on shop lighting. It is here pointed out that hard and fast rules as to the amount of light required do not answer; each department of a shop has to be considered separately, according to the class of goods to be shown.

ELECTRIC LIGHTING.

Reference may first be made to several papers published in recent numbers of the *E.T.Z.*, which were read at the Annual Meeting of the Verband Deutscher Electrotechniker. Thus **Bermbach** describes a NEW TYPE OF ARC LAMP using parallel carbons, but working with practically NO REGULATING MAGNETISM. **Liebesney** sums up PROGRESS IN THE METALLIC FILAMENT GLOW-LAMP during the past year. He gives a series of curves illustrating the connexion between the specific consumption and useful life of a lamp, and draws the conclusion that no good result has yet followed the attempt to manufacture lamps running at less than about 1 watt per Hefner. At present, therefore, manufacturers are mainly engaged in extending the limits of candle-power of lamps for the given voltage.

The Presidential address of **H. W. Hillmann** at the Annual Convention of the Michigan Electric Association, makes special reference to the value of TUNGSTEN LAMPS FOR STREET LIGHTING. The use of arches of Tungsten lamps in series is said to be proving very satisfactory, and

many towns are now establishing a higher standard of lighting than was previously thought necessary; in some cases 60–70 K.W. per mile are used where only 7 was formerly employed. An author in the *Oesterr. Ungar. Installateur* describes a modification in methods of treating the vacuum of glow-lamps which, it is claimed, is very effectual in preventing subsequent blackening of the bulb. A recent number of *Electrical Engineering* contains some particulars of patents on the manufacture of tungsten filaments. An article on considerable interest in the *Schweizerische E.T.Z.* describes an association formed in Switzerland controlling the purchase of glow-lamps, particulars being given of the regulations by which members of the Association agree to be bound.

Among other papers on arc lamps we may refer to an interesting summary by **Auerbacher** (*T.I.E.S.*, June), who deals with the Evolution of the Flame Arc. A recent number of *The Electrical Review* contains a translation of **B. Monasch's** article in the *E.T.Z.* on the Progress in Arc Lamps; the article is of a general, but up-to-date nature. **F. R. Pierce** refers to the value of the flame arc for street lighting, and especially for large areas. A writer in *The Electrical World* mentions the same point in connexion with Street Lighting in Boston. As previously stated in this journal, however, the streets in this City are to be *mainly* illuminated by series magnetite arc lamps.

Special mention may next be made of a series of articles in *The Electrical Review* of New York (Sept. 11th). Chief among tiese we may mention the article by **Dr. Louis Bell** on Domestic Lighting, in which he expresses a view that methods of automatically extinguishing gas lights are not yet sufficiently developed to compare with the conveniences of electricity. The author also states that, in all ordinary cases, $\frac{1}{4}$ watts per square foot of floor area suffices for a room lighted by tungsten lamps. **A. J. Mitchell** gives yet another paper summarizing Recent Developments in Arc Lighting. Mention is made of the new titanium carbon arc lamp, which is credited with a consumption of 0·3 watts per candle-power, but is still in the experimental stage.

Attention should be drawn to several recent notes in *The Electrical World.* One of these refers to Animated Signs; for instance, one sign shows a bottle of ginger ale, the cork of which is made to fly out and its contents foam over. Other signs simulate falling rain, and other natural phenomena by extinguishing or switching on the light of certain groups of glow-lamps. The same journal (Aug. 26th) also contains reference to the value of Mercury Vapour Lamps for Signs.

Lastly reference may be made to the article by **G. Werner** (*Z.f.B.*, Aug. 20th), who discusses the requirements of three different classes of consumers, namely, those for whom economy is the main consideration, those who desire good lighting, but not at an exorbitant cost, and those who must secure at all costs the most perfect illumination obtainable. He also considers the type of measuring instruments each class would require, and describes a small portable type of watt-photometer which has recently been put upon the market.

GAS, OIL, ACETYLENE, &c.

The Automatic Control of Gas Lights at a Distance continues to receive attention. For instance, several papers at the annual meeting of the Société Technique de l'Industrie du Gaz deal with the matter. Recent numbers of the *Zeitschrift für Beleuchtungswesen* (Sept. 10th, 20th) are also devoted to methods depending on a temporary rise of pressure.

R. Bremer (*Z.f.B.*, Aug. 30th, Sept. 20th) contributes an interesting article on High-Presusre Gas Lighting, in which he traces the improvement since the days of flat-flame burners, and refers to recent developments in Berlin. In this connexion he speaks of the difficulties encountered in connexion with breakages of mantles and globes, and states that these were eventually overcome by the concerted efforts of the laboratories of the City, of the Selas Company, and of Messrs. Ehrich & Grätz. He also mentions that the high-pressure supply is at present controlled from six distinct local stations. It is now proposed to interconnect the mains from all these points, so that the pressure of the whole system may be subjected to common control.

In this connexion it is interesting to notice that Blackfriars Bridge (London) is now lighted by high-pressure gas (*Gas World*, Sept. 10th).

An article by **E. B. Crady** (*Prog. Age*, Sept. 1st) discusses the competition between high-power gas and electric sources. *The Jour. of Gas Lighting* (Sept. 21st) has a short note on the Airostat inverted burner, the essential feature of which is the provision of an arrangement for automatically regulating the consumption of air, according to the temperature of the burner, the quality of gas, and other local conditions. Another interesting note in a recent number of the *Zeitschrift für Beleuchtungswesen* deals

with the possible manufacture of a lamp chimney which, when it breaks, does not smash the mantle inside. One method of accomplishing this is by melting inside the glass a suitable network of wires.

Recent numbers of the *Am. Gas Light Journal* again contain several notes on the advertising possibilities of gas lamps. For instance it is becoming customary, in showing lamps, to arrange practical demonstrations of the developments of gas-lighting fixtures. Old and badly adjusted flat flame burners are shown side by side with the most up-to-date types, and these in turn are contrasted with incandescent mantles. Exhibits are also arranged, showing the development of the candle. Attention is also drawn to the use of lamp-posts for advertising devices. In the olden days, when only comparatively weak illuminants were available, their value in this connexion was not so readily recognized. Now, however, companies are in existence who pay the City a certain sum for the right to attach advertisement signs to lamp posts in different localities. These companies sub-let the rights again to shops, theatres, &c., which are glad to make use of lamp-posts adjoining their premises.

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Cravath, J. R. Street Lighting in Small Towns (*Elec. World*, N.Y., Sept. 2).
Editorials. Developments in Street Lighting—International Unit of Light—Gas Competition—Ultraviolet Light (*Elec. World*, N.Y., Sept. 2).
Heterochromatic Photometry and its Difficulties (*Elec. World*, N.Y., Aug. 19).
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Elliott, E. L. Exterior Lighting Fixtures (*Illum. Eng.*, N.Y., Sept.).
Measuring Colour by Numbers (*Illum. Eng.*, N.Y., Sept.).
Gartley, W. H. A Short Review of the Work of the Illuminating Engineering Society (*T. I. E. S.*, May).
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Steinmetz, Dr. C. P. Illumination and Illuminating Engineering (Paper read before the Illuminating Engineering Society, *J. G. L.*, Sept. 21. abstr.).
Weinbeer, E. W. Die Strahlengesetze leuchtender Flächen (Schweiz, *E. T. Z.*, Aug. 7).
Wissmann, W. The Reputed Candlepower of Lamps (*G. W.*, Sept. 4, translation).
Observations and Advice on Shop Lighting (*J. G. L.*, Sept. 7).
La Qualité des differents luminaires (*Jour. de l'Union des Proprietaires d'Appareils à Acétylène*, July-August).
The Name of the Proposed International Unit (*J. G. L.*, Aug. 31).
The Deleterious Effects of Bright Light on the Eyes (*J. G. L.*, Aug. 31).

ELECTRIC LIGHTING.

Auerbacher, L. T. The Evolution of the Flaming Arc (*T. I. E. S.*, June).
Bell, Dr. L. The Problem of Domestic Lighting (*Elec. Rev.* N.Y., Sept. 11).
Bermbach. Eine Universallampe mit parallelen Kohlen Selbstregulierend ohne Regelwerk (*E. T. Z.*, Sept. 2).
Bloch, Dr. L. Elektricität im Wohnhause (*A. E. G.*, Zeitschrift, Sept.).
Crouch, L. Metallic Filament Lamp Transformers (*Elec. Rev.*, Sept. 3, 10).
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Libesney, A. Die weitere Entwicklung der Metallfaden-lampen auf Grunde der Erfahrungen des letzten Jahres (*E. T. Z.* Aug. 19).
Mitchell, A. J. Developments of Arc Lighting (*Elec. Rev.* N.Y. Sept 11.).
Monasch, B. Recent Progress in Electric Lighting (*Elec. Rev.*, Aug. 27, Translation from article in *E. T. Z.*).
Pierce, F. R. The Flaming Arclamp as a Street Lighting Unit (*Illum. Eng.* N.Y. Sept.).
Ruckel. Uber Bestimmung der Selbstkosten für elektrischen Strom bei verschiedener Benutzungsdauer (*J. f. G.*, Sept. 11.)
Seager, J. A. Electric Illumination Topics in Great Britain (*Illum. Eng.* N.Y., Sept.)
Schrœder. Tungsten Signlighting (*Elec. Rev.*, N.Y., Sept. 11).

Werner, G. Wie kann die Wirtschaftlichkeit einer elektrischen Beleuchtungsanlage günstig beeinflust werden? (*Z. f. B.*, Aug. 30).
Electric Supply and Trials for Shopkeepers (*Electricity*, Aug. 27).
Arc Lamp Standards (*Electricity*, Aug. 27).
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Elektrische Glühlampen mit klar-bleibenden Glasballons (*Oesterr-Ungar Installateur*, Aug. 7).
The Manufacture of Tungsten Filaments (*Elec. Engineering*, Sept. 10).
A New Design of Enclosed Arc Lamp (*Elec. Engineering*, Sept. 10).
The Cause of the Offensive Odour of Mercury Vapour Lamps (*Elec. Engineer*, Aug. 27).
The Taxation of Electric Lamps (*Elec. Engineer*, Aug. 27).
The new B.O.T. Regulations (*Elec. Engineer*, Aug. 27).
Electric Spectacular Lighting (*Elec. World*, N.Y., Sept. 9).
Die Thaumalampe (*E. T. Z.*, Sept. 16).
Streetlighting Conditions in Boston (*Elec. World*, N.Y., Sept. 2).
Large Animated Signs in New York (*Elec. World*, N.Y., Sept. 2).
A Notable Example of Indirect Lighting (*Elec World*, N.Y., Sept. 9).
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GAS, OIL, AND ACETYLENE LIGHTING.

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Bremer. R. Pressgasbeleuchtung (*Z. f. B.*, Aug. 30, Sept. 20).
Crady, E. B. High Candle Power Competition (*Prog. Age*, Sept. 1).
Editorials. Metallic Filament Gas Mantles (*J. G. L.*, Sept. 14).
Rowe, E. B. Gaslighting Shop Window Equipment (*Gas Engineer's Magazine*, Sept. 15).
Gas-zundvorrichtungen (*Z. f. B.*, Sept. 10, 20).
The Lighting of Blackfriars Bridge (*G. W.*, Sept. 10).
Meeting of the Sociétè de l'Industrie du Gaz (*Le Moniteur Technique de l'Industrie du Gaz*, Aug. 31, *L'Electricien*, Sept. 11).
The Airostat Inverted Gas Burners (*J. G. L.*, Sept. 21).
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Four Times the Light for One-half the Money! (*Am. Gaslight Jour.*, Aug. 30).
The Chronic Fault-Finder (*Am. Gaslight Jour.*, Aug. 30).
Advertising Gas Illumination Business (*Am. Gaslight Jour.*, Aug.-Sept. 6).
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L'Industrie des Becs a Acetylene (*Rev. des Eclairages*, Aug. 15).
L'Eclairage Publique des Grands Capitals (*Le Moniteur de l'Industrie du Gaz*, &c., Aug. 31).
Lampenzylinder mit Drahtanlage (*Z. f. B.*, Sept. 10).
Bericht über die Tätigkeit der Gasmesserkommission (*J. f. G.*, Sept. 18).

CONTRACTIONS USED.

E. T. Z.—*Elektrotechnische Zeitschrift.*
G. W.—*Gas World.*
Illum. Eng., N.Y.—*Illuminating Engineer of New York.*
J. G. L.—*Journal of Gaslighting.*
J. f. G.—*Journal für Gasbeleuchtung und Wasserversorgung.*
Prog. Age.—*Progressive Age.*
Phys. Rev.—*Physical Review.*
T. I. E. S.—*Transactions of the Illuminating Engineering Society, United States.*
Z. f. B.—*Zeitschrift für Beleuchtungswese*

Annual Meeting of the Iron and Steel Institute.

The annual meeting of the above Institute took place from September 27th to October 1st in London. A very varied selection of papers was delivered at the meetings in the premises of the Institution of Civil Engineers, and an attractive series of visits was arranged, including, we understand, a special day-visit to Portsmouth Dockyard. A programme of social events was also arranged including a visit to a special performance of 'The Proud Prince' at the Lyceum Theatre, and a dinner at the Trocadero Restaurant. Information regarding the Iron and Steel Institute may be obtained from the Secretary, 28, Victoria Street, London, S.W.

CORRESPONDENCE.

A Name for the International Unit of Light.

Sept. 15, 1909.

DEAR SIR,—You ask for comment on Mr. Blondel's interesting and suggestive note on 'The Name of the International Candle Unit,' printed in your August issue. One or two points may be remarked in criticism of his suggestions—particularly in his choice of a name for the unit.

In desiring to name the unit after M. Violle, does not Mr. Blondel lose sight of the fact that the value of the new unit in terms of the Violle standard cannot be regarded as defined with anything approaching the accuracy of modern photometric methods ? On the one hand, the French authorities, taking M. Violle's own ratio between the platinum unit and the Carcel unit (determined in 1881) claim that the so-called international unit is exactly one-twentieth of the candle-power of the platinum standard (viz., the Bougie Decimale). On the other hand, the International Congress of Electricians declared at Geneva in 1896 that the Bougie Decimale is the same as the Hefner unit. We know the Hefner Unit to be 10 per cent smaller than the proposed International unit, hence there is an uncertainty of 10 per cent in the true interpretation of M. Violle's platinum standard. Is this really the same as the unit which is now known as the Bougie Decimale in France, or is it equal to the Hefner Unit ? We know at present that this country, France, and America, have a common *unit*, but I think most people would regard it as a mistake at the moment to attach the name of any one standard to this unit. The *unit* can be maintained at its present value almost indefinitely to a fraction of 1 per cent, but it will be generally admitted that no present standard has been proved to be so independent of atmospheric or other conditions of test as to justify its universal and permanent adoption as representing the value of an international unit of light. To link the unit with any standard might even prejudice people against its adoption.

Should a single unit be ultimately adopted by all countries of the world, I cannot agree with Mr. Blondel that it would be cumbersome to call it an international unit. We are quite accustomed to the "Int. Ohm,"—why not have an "Int. Candle," an expression which carries its meaning on the face of it and would be understood by both technical and untechnical persons ?

There are other points in connexion with Mr. Blondel's suggestions which have probably already occurred to your readers, and I will not, therefore, trespass further on your space.

Yours truly,

C. C. PATERSON.

The National Physical Laboratory.

Association of Engineers-in-Charge.—New President.

WE are informed that the Council of The Association of Engineers-in-Charge have unanimously elected Mr. Henry Adams, M.Inst.C.E., M.I.Mech.E., &c., as their President in succession to Mr. James Swinburne, F.R.S., M.Inst.C.E., and that an attractive programme has been drawn up for the new session, including some good papers and several social functions.

PATENT LIST.

COMPLETE SPECIFICATIONS ACCEPTED OR OPEN TO PUBLIC INSPECTION.

I.—ELECTRIC LIGHTING.

18,054/08. Incandescent lamps (C.S.). I.C. Sept. 16, 1907, U.S.A. Accepted Sept. 1, 1909. W. C. Arsem, 83, Cannon Street, London.

19,150. Electric light fittings. Sept. 11, 1908. Accepted Sept. 15, 1909. A. T. Woodhall and A. Emery, 70, Chancery Lane, London.

19,183. Electroliers. Sept. 12, 1908. Accepted Aug. 25, 1909. R. S. Woods, 4, St. Ann's Square, Manchester.

22,003. Anti-vibration device for pendants, &c. Oct. 17, 1908. Accepted Sept. 1, 1909. A Newall, 73, Approach Road, Victoria Park, London.

28,177. Sockets for incandescent lamps. Dec. 24, 1908. Accepted Sept. 15, 1909. H. W. Marsh, Birkbeck Bank Chambers, London.

28,554. Flat filaments for metallic filament lamps (C.S.). I.C. Jan. 2, 1908. Accepted Aug. 25, 1909. W. Schäffer, 111, Hatton Garden, London.

1,673/09. Holders for incandescent lamps. Jan. 23, 1909. Accepted Aug. 25, 1909. T. Birchall, 55, Market Street, Manchester.

8,283. Regenerating blackened carbon filament lamps (C.S.). I.C. April 6, 1908, Germany. Accepted Sept. 1, 1909. E. A. Krüger, 18, Southampton Buildings, London.

10,312. Safety lamps (C.S.). I.C. May 2, 1908, Germany. Accepted Sept. 15, 1909. G. O. Wolters, 4, South Street, Finsbury, London.

19,465. Device for varying the intensity of electric lamps (C.S.). I.C. Aug. 26, 1908, Italy. A. de Stefano, 6, Lord Street, Liverpool.

II.—GAS LIGHTING.

15,143/08. Gas pendants and burners. July 17, 1908. Accepted Aug. 25, 1909. G. Helps, Izons croft, Ausley, Atherstone.

18,860. Gas lighting and extinguishing apparatus. Sept. 8, 1908. Accepted Sept. 15, 1909. Sir E. H. Elton and R. Stephens 27, Chancery Lane, London. Addition to 15,067/06.

20,348. Automatic gas lighting and extinguishing apparatus. Sept. 28, 1908. Accepted Aug. 25, 1909. B. Bonnilssen and T. Berridge, 18, Hertford Street, Coventry.

24,630. Incandescent mantles for inverted burners. Nov. 16, 1908. Accepted Sept. 15, 1909. L. Friedeberger, 323, High Holborn, London.

25,428. Incandescent gas lamps (C.S.). Nov. 25, 1908. Accepted Sept. 1, 1909. R. D. Cody, 33, Chancery Lane, London.

4,332/09., 4,333. Automatically lighting and extinguishing street lamps (C.S.). I.C. April 15 and Oct. 15, 1908. Accepted Sept. 8, 1909. A. J. Bedford, 40, Chancery Lane, London.

6,588. Inverted incandescent burners (C.S.). March 19, 1909. Accepted Sept. 1, 1909. J. W. Fisk, 33, Castle Arcade, Cardiff.

7,497. Revolving shade suspender for gas pendant brackets (C.S.). March 29, 1909. Accepted Sept. 8, 1909. J. Smith, 55, Chancery Lane, London.

9,149. Inverted gas burners (C.S.). April 17, 1909. Accepted Sept. 15, 1909. G. Wahl and A. Bayerwahltes, 4, South Street, Finsbury.

10,743. Supporting means for globes of inverted incandescent burners (C.S.). May 6, 1909. Accepted Sept. 1, 1909. A. Bray, Sunbridge Chambers, Bradford.

19,212. Valve devices for incandescent burners (C.S.). I.C. Aug. 26, 1908, Germany. Neue Kramerlicht G. m. b. H., 7, Southampton Buildings, London.

III.—MISCELLANEOUS.

(including lighting by unspecified means, and inventions of general applicability).

23,521/08. Balanced drop lights for railway vehicles, &c. Nov. 3, 1908. Accepted Sept. 8, 1909. J. D. Twinberrow and R. C. McKerrow, 18, Southampton Buildings, London.

3,892/09. Portable hand-lamps (C.S.). Feb. 17, 1909. Accepted Sept. 8, 1909. S. J. Harcourt and T. M. Markham, 129, Cave Hill Road, Belfast.

4,425. Electromagnetic systems for controlling lights on railway trains, &c. (C.S.). Feb. 23, 1908. Accepted Sept. 1, 1909. Siemens Bros. Dynamo Works, Ltd., F. G. Broadhead, and S. Hawkins, 139, Queen Victoria Street, London.

7,311. Lamp-reflectors, &c. March 26, 1909. Accepted Sept. 8, 1909. E. R. Rysman, 70, Chancery Lane, London.

18,350. Incandescent oil lamp (C.S.). I.C. Sept. 2, 1908, Australia. J. C. Preston, 60, Queen Victoria Street, London.

EXPLANATORY NOTES.

(C.S.) Application accompanied by a Complete Specification.

(I.C.) Date applied for under the International Convention, being the date of application in the country mentioned.

(D.A.) Divided application : date applied for under Rule 13.

Accepted.—Date of advertisement of acceptance.

In the case of inventions communicated from abroad, the name of the communicator is given after that of the applicant.

Printed copies of accepted Specifications may be obtained at the Patent Office, price 8*d*.

Specifications filed under the International Convention may be inspected at the Patent Office at the expiration of twelve months from the date applied for, whether accepted or not, on payment of the prescribed fee of 1*s*.

N.B.—The titles are abbreviated. This list is not exhaustive, but comprises those Patents which appear to be most closely connected with illumination.

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EDITORIAL.

Third Annual Convention of the Illuminating Engineering Society.

IN our last number we made some remarks upon the excellent selection of papers presented at the Third Annual Convention of the Illuminating Engineering Society, which took place in New York on September 27th, 28th, and 29th of this year. We think that they are, perhaps, of an even more interesting character than at the last Convention, and our readers will be able to judge from the short abstract of the Proceedings which we publish on p. 747 as to the varied nature of the subjects which they cover.

In the present number we also reproduce some of these papers in greater detail, and we hope to present some of the others in our next few numbers. There are one or two points in these papers which seem to stand out as of special interest and importance.

The Society have a happy method of bringing together a series of two or more papers dealing with several correlated aspects of the same subject. It will be noted, for example, that Mr. C. O. Bond and Dr. E. P. Hyde have presented papers at this Convention, dealing with the Photometrical Laboratories, established by the United Gas Improvement Co. and the National Electric Lamp Association respectively. It is very gratifying to notice two important concerns connected with these two illuminants making progress in the direction of scientific research. In the paper which Dr. Hyde has sent us reference is made to the objects of the Laboratory under his charge, and we cannot but express our appreciation of the sound lines on which the proposed researches are to proceed.

Dr. Hyde recognizes at the outset that a very large section of the problems met with in Illuminating Engineering can only be solved by the concerted action of physiologists and physicists. It is, therefore, proposed to seek the advice of experts connected with both professions, and to collect data bearing on the connexion between the physiological and Engineering aspects of the subject.

This same point seems to be brought

out very clearly by Mr. P. S. Millar who has delivered a paper on the problems of Heterocromatic Photometry. This particular subject is notoriously full of points on which authoritative data are badly needed, and its complexity has been added to by the fact that so many of the principles on which photometry depends are essentially physiological. All those who are interested in photometry will join in approval of the resolution passed at the Convention to form a Committee to deal with this subject.

Another group of papers which deal with closely-related subjects are the three presented by Prof. G. S. Barrows, Mr. Simonini, Dr. Ives, and Dr. Coblentz, respectively. The work of Auer von Welsbach, Chemical Luminosity, and the Study of Light from the Fire-fly are all fascinating subjects to the Illuminating Engineer. Very important work on radiation has been done in the United States by Dr. Coblentz and others, and it is quite possible that the study of these phosphorescent sources of light, weak in intensity as they now are, may yield valuable suggestions for future progress.

We cannot pause to refer to as many of the important questions raised at this Convention as we should like, did space permit. There are, however, still several matters which deserve special mention. A question which has already arisen in the United States, and with which we, in this country, will doubtless have to deal shortly, was raised by Mr. E. L. Elliott in his paper on the Ethics of Illuminating Engineering.

If the term "Illuminating Engineer" is to receive its full significance, and those who thus describe themselves are to command the respect of the engineering public, it is essential that we should exercise a wise restraint in making use of the term at present, and especially in applying it to individuals. There are at the present time very few men indeed, either here or in the United States, who can claim to have studied illuminating engineering in all its branches so fully as to deserve to be called "illuminating engineers" in the strict sense.

This being so it is certainly to be desired that unqualified persons should not be encouraged to style themselves "illuminating engineers" and so bring the title into disrepute. As we have frequently insisted, membership of the "Illuminating Engineering Society" does not imply that every member is strictly speaking an "illuminating engineer." We are all engaged on a career of self-education at present. We are studying the subject of illuminating engineering, and if we persist in doing so some of us may earn the right to be called "illuminating engineers"; but we do not earn this title by merely embarking on the study.

Another matter of some importance was dealt with in the paper presented by Mr. K. Richtmyer on 'The Educational Aspects of Illuminating Engineering.' It is very gratifying to find that Cornell and other Universities in the United States are establishing definite courses in which an attempt is made to group together the various subjects usually regarded as coming under the scope of illuminating engineering; a special course, we note, is suggested for the benefit of architects. It is of course to be expected that such a course should shape itself gradually into the required channels. It is, however, necessary to make a start, and the time is certainly ripe for a movement in this direction. Such a course seems to be crystallizing at the Northampton Institute under the care of Dr. C. V. Drysdale and others, and it is to be hoped that many technical colleges in this country will see their way to improve the existing facilities in this direction.

Factory Lighting.

Mention may also be made of the valuable paper by Mr. L. B. Marks on 'Factory Lighting.' As a record of conditions of illumination in several factories and the possibilities of improving them, this paper will doubtless prove very valuable for reference to illuminating engineers.

One of the most striking points brought out by Mr. Marks is the difference in the conditions of daylight and artificial illumination in the factories visited. In some cases the general artificial illumination was found to be very much lower than that prevailing in the daytime. In other cases there was a tendency to concentrate the light upon the work unduly, and to furnish an amount of illumination which was not necessary and might have been profitably distributed in order to lighten the sombreness of the surroundings. In many cases, Mr. Marks suggested, the direct reflection of light from shining metal surfaces was distinctly distressing to the eyes of the operator, and led him to desire a stronger illumination than would have been really needed for the work if the light had been properly directed.

Yet another interesting fact in the records established by Mr. Marks is the apparent divergent conditions of illumination in rooms, presumably devoted to identical purposes, in different factories. It will probably be some time before the conditions of illumination required for different classes of work become standardized, but such records as this should help us to form some useful conclusions in this direction.

New Fixtures in Old Houses.

There are few problems in which more diverse factors have to be borne in mind and more distinct views reconciled than the lighting of old buildings of great historic importance and considerable artistic pretensions. In many cases we are faced with the difficulty of compromising between the practical convenience of the present and compliance with the artistic conditions of the past. It is interesting now to note the affectionate regard for candles in the early days of the nineteenth century when Dr. D. B. Reed, who suggested the introductions of gas-lighting into the Houses of Parliament, was met by the rejoinder: "Do what you will for the acoustics and ventilation, but take it as a fixed and settled point that wax candles remain." Nevertheless, eventually the newer illuminants—gas and electricity—were introduced.

In the last number will be found a reference to the introduction of electricity in Caen Wood House, the residence of the Earls of Mansfield, which, it is stated, was until two years ago lighted exclusively by candles. There are probably many old mansions still, in this country, which have only recently adopted the newest illuminants or are still hesitating between the ancient and modern. The choice in such cases must, of course, greatly depend on the local conditions.

There is, however, one point of which stress may be laid. If it is decided to adopt modern systems of illumination, the decision should be backed up by the intention to secure the provision of illumination carried out in a thoroughly satisfactory manner, and, as far as possible, in harmony with the style of the interiors. The grudging of the necessary care and expense in this respect can only lead to dissatisfaction. In some cases it almost seems as if all attempts were given up of trying to make the new illuminants artistic. Some of the electric fittings put in are of a cheap and tawdry character, such as would hardly be tolerated as a fixture by an architect in a good modern interior. Naturally, under these conditions, the new illuminants are quite unsuited to their surroundings, and do not show to advantage, in comparison with the simple but well-studied system of a bygone age, either from an æsthetic

or even utilitarian standpoint. The introduction of the new illuminant on these lines may have the effect of an artistic incongruity, and yet, for want of reasonable care, even prove unsatisfactory from the point of view of convenience and comfort.

These are cases in which the services of the illuminating engineer are badly needed, and in conjunction with the architect, he could often give valuable assistance in putting the illumination on a better utilitarian and artistic footing.

A Standard Specification for Wax Candles in the 14th Century.

On page 734 of this journal will be found an article based on information supplied by a contributor regarding the privileges of the Wax-Chandlers from the days of King Richard III., which is not only very interesting historically but is surprisingly suggestive when applied to modern conditions.

We see, for example, how the citizens of London made resolute efforts to secure purity and rigid adherence to standard conditions in the Wax Candle which, at that time, seems to have been the only available illuminant for street lighting. The petition for improving regulations "for the profit of the common people," is, indeed, nothing less than the expressed desire for a very vigorous standard specification. In addition, it is advocated that a mark should be stamped upon all candles duly manufactured in accordance therewith. Let it be noted, too, that in seeking to form a board capable of enforcing this recommendation, recourse was had to *expert opinion*, *e.g.*, the services of 'Four of the lawful folks of the said trade,' and severe penalties were imposed upon the man who sold candles that were not up to their professed constitution.

At the present day, when so many illuminants are available, the need for a specification of this kind is becoming very keenly felt, and in these columns attention has been particularly drawn to the desirability of such a standard in connexion with Metallic Filament lamps; also of the provision of a certain mark to be stamped on each lamp stating what it was intended to accomplish. Such a mark, we have observed, is precisely what was recommended in the case of the Wax Candles as a guarantee of good quality. This is a matter to which the Engineering Standard Committee, having already done such good work in this direction, will, we hope, give their attention.

We do not desire to revive the pillory, which formed such an important item for the punishment of those who manufactured adulterated candles, or to prescribe a whipping for the benefit of those who to-day sell bad carbon filament lamps under the guise of metallic filament lamps. It is evident, however, that until some standard conditions become legal we shall suffer from frauds of this description.

But a few months ago reference was made in these columns to several cases of this kind. In one instance the swindlers merely supplied overrun carbon filament lamps, the bulbs being frosted in order to prevent the consumer observing the nature of the filament. That such cases illustrate an important principle was shown by the publicity given to this note in other journals.

The lesson to be drawn from the experiences of the City of London about 500 years ago is, therefore, obvious. If at that time the need for a standard specification, and for a central authority controlling public illumination, was realized, how much more to-day when we have no longer to deal with a single illuminant but to distinguish between the claims of an ever-growing army of new lamps! At the same time it is, of course, only fair to recognize that the constant development in methods of lighting adds to the complexity of the problems.

We hope shortly to deal again with this very important question.

LEON GASTER.

Review of Contents of this Issue.

Mr. A. P. Trotter (page 727) continues his remarks on ILLUMINATION PHOTOMETERS. He refers to Mr. P. S. Millar's work on this subject, and summarises some of his suggestions regarding the conditions with which a good instrument ought to comply. He then turns to the description of several early forms of illumination photometers devised by Sir William Preece and himself in 1895 and subsequently. In so doing Mr. Trotter refers to the various difficulties encountered and the special means adopted to facilitate the adjustment of the illumination of the photometer screen and the design of the scale on which the measurements made are recorded.

Dr. M. Gaster (p. 731) continues his contribution on LIGHT IN CUSTOM AND SUPERSTITION. He proceeds to show how the appearance of the heavens and phenomena connected with light came to be associated with life and death and the belief in immortality. In this way arose those customs involving the lighting of tapers by the bier, &c. which celebrated the death of the body and the pilgrimage of the soul. Such practices are met with in all quarters of the globe, not only in modern European nations, but also among the Japanese and Chinese and the aboriginees of America.

Dr. B. Monasch (p. 742) refers to the relations between the UNITS OF INTENSITY OF ILLUMINATION USED IN DIFFERENT COUNTRIES. This has been tabulated in a table in a previous, number of this journal (vol. 1, 1908, p. 151), but the adoption of the common international unit of light between Great Britain, France, and the United States has led to a great simplification. The author, therefore, presents a new table showing the present state of affairs.

On page 734 will be found a contribution in which some particulars are given of the CHARTER GRANTED BY KING RICHARD III. to the GUILD OF WAX CHANDLERS, and the ordinances established for the sale of candles according to rigid specification as to material, &c. It is pointed out that these ordinances form a very interesting precedent for a STANDARD SPECIFICATION FOR ILLUMINATING APPARATUS, and illustrated at this early date, the need for a central authority to control matters of illumination. In modern times, when we have no longer to deal with only a single illuminant, but with constant developments in methods of illumination, such an authority is even more to be desired.

On p. 747 will be found a brief account of the Proceedings at the THIRD ANNUAL CONVENTION OF THE ILLUMINATING ENGINEERING SOCIETY, reference being made to the chief papers read on this occasion. The papers were of a very representative character, dealing with general problems in illuminating engineering, "The Design of Shades and Reflectors," "Photometrical Laboratories," 'Problems in Radiation as Applied to the Production of Light,' &c.

The first part of the paper presented by **Mr. L. B. Marks** on this occasion is reproduced in the present number (p. 752). The author describes the results of inspecting the CONDITIONS OF ILLUMINATION IN SEVERAL FACTORIES, both daylight and artificial. He points out that the natural and artificial systems of lighting often differ very widely both in intensity and method of distribution. In many cases a much lower order of artificial illumination would have been satisfactory, and a corresponding saving would have been affected, if only the light were applied in a more diffused manner.

This paper is followed by that of **Dr. E. P. Hyde** (p. 758),who describes the objects of the LABORATORY ESTABLISHED BY THE NATIONAL ELECTRIC LAMP ASSOCIATION, and under his supervision. Besides dealing with re-

searches connected with physics, radiation, &c., the physiological aspects of the subject will be borne in mind. It is, therefore, proposed to invite the assistance of both physiologists and physicists, and the opinion is expressed that the complexity of the subject makes concerted action of this kind necessary and valuable.

On pp. 762–768 will be found some popular notes on illuminating engineering. Reference is made on p. 762, to Shop Lighting. Attention is drawn to the new tendency in many shops to regard the window not as a catalogue, but as a place where the most recent developments are shown. On this basis the overcrowding of windows is avoided and the problems of satisfactory illumination simplified.

A cartoon on p. 763, reproduced from *Electrical Industries and Investments*, illustrates the troubles of the electrical contractor called upon to reconciles the conflicting views of his client as to where the sources of light in a room should be located. Attention is drawn to the value of the expert illuminating engineer who is in a position to arbitrate between the different parties and promote a better understanding.

On p. 765 will be found the first of our Light Conversations on Illuminating Engineering. The present instalment deals with the subject of Glare. In this discussion the gas engineer, the electrical engineer, and others, take part, and the decision is reached that only by means of full discussion on the part of all those interested can definite and authoritative data be obtained and the formation of one-sided views avoided

Among other articles in this number we may mention that by **Mr. Fulweiler** (p. 769) on The Theory of Flame and Incandescent Mantle Luminosity, which is concluded in the present number. **Mr. Norman Macbeth** (p. 771 deals with the Importance of Illuminating Engineering to the Gas Industry. He insists that it is in the interest of the gas engineer to attempt the scheming out of methods of illumination on scientific lines and to encourage the compilation and distribution of genuine information bearing on the subject.

On p. 743 will be found some notes on the developments of Gas Lighting in Berlin by a German Correspondent. This is followed by a note on The Spectacular Lighting of a Public Hall in Frankfort, which is carried out by the aid of a series of flame arcs, hung high up above the line of sight of the audience, and miniature electrical glow lamps outlining the arches, galleries, &c.

On p. 761 reference is made to the discovery of **Dr. Edeleanu** with regard to the Refinement of Roumanian Petroleum. Hitherto oil of this kind was apt to smoke and smell when used for illuminating purposes. It is now suggested that this was due to the presence of certain aromatic compounds in petroleum which were not removed by the process of purification. By treatment with sulphur dioxide these disappear and the defects of the oil for illuminating purposes are no longer in evidence.

On p. 776 will be found reference to a paper by **Prof. W. Barret,** describing some researches on the measurement of the Reflecting Power of Different Surfaces.

A note on p. 777 refers to the tendency towards reducion in candle-power of metallic filament electric glow lamps ; this is followed by a short account of the death of Mr. C. J. Robertson, the engineer and manager of the Robertson Lamp Works, which occurred on October 6th.

Our correspondence columns contain communications from **Dr. L. Bloch, Prof. A. Blondel,** and **Mons. F. Laporte** (p. 773). Dr. Bloch replies to a criticism on his method of illustrating the distribution of light in space to the analogy of a Sand Blast, Mons. F. Laporte and Prof. Blondel deal with the question of the Name for the International Unit of Light, and comment upon the communication of Mr. C. C. Paterson to our last number.

At the end of this number will be found reviews of several books (p. 786), the usual Review of the Technical Press (p. 787), and the Patent List (p. 791).

TECHNICAL SECTION.

[*The Editor, while not soliciting contributions, is willing to consider the publication of original articles submitted to him, or letters intended for inclusion in the correspondence columns of 'The Illuminating Engineer.'*

The Editor does not necessarily identify himself with the opinions expressed by his contributors.]

Illumination, Its Distribution and Measurement.

By A. P. Trotter,

Electrical Adviser to the Board of Trade.

(*Continued from p.* 659.)

Mr. Millar's Criticisms on Illumination Photometers.—The paper by Mr. P. S. Millar, to which reference has been made, differs greatly from the colourless descriptions of Palaz, Liebenthal, and other writers, by reason of his keenly critical comments on and comparisons between the various patterns of instruments. With reference to the method of varying the illumination by a turning screen, he writes, "The variation of the inclination of a plane with reference to the light incident upon it, or to an angle at which it is viewed, is an unsatisfactory method; first, because unless a perfect diffusing surface is obtained, the cosine law will not apply, and the instrument should be calibrated empirically; second, because any surface which approximates to a perfect diffusing surface is likely to change in character, which would introduce an error into the scale calibration of the instrument; and third, because the scale calibration of an instrument in which this is used becomes very narrow with low intensities, so that the slightest displacement of the plane will produce a marked difference in the illumination in the region where the photometric comparison is rendered difficult because of the low intensity which is being studied." Mr. Millar states his preference for the variable distance method, which he considers far superior in that it possesses "accuracy, reliability, ease of verification, calibration according to a known law, simplicity, a wide range and universal application." It is true that several illumination photometers have been proposed, in which the variable distance method is used, but the range, as has been already observed, must be very limited if this alone is employed. The lamp cannot be brought nearer than about 6 inches from the screen without risk of a departure from the square law, or unequal illumination of the working part of the screen. In order to reduce the illumination to 1/50 the lamp must be moved to a distance of more than 3 ft. 6 in., and to reduce it to 1/200, which can be done with but little difficulty with a tilting screen, it must be moved to more than 7 ft. No illumination photometers in which the variable distance method is used, are able to measure directly the feeble illuminations found in ordinary street lighting, such as 0·003 foot-candle, without supplementing the method of reducing the illumination by absorbing screens or some such device. The upper limit should be at least 2 foot-candles, and preferably 4. I find that Mr. Millar's criticisms, useful as they are, do not condemn the rotating screen. In the first place, the "perfect diffusing surface" is quite unnecessary. Any piece of ordinary fairly white cardboard will do. All such instruments must be graduated by experiment, and the

moving screen need not obey the cosine law at all. The only matter to be observed is that there should be no considerable glaze, and that it should not be used near a position in which the angle of incidence of the little lamp in the photometer is nearly equal to the angle of emission or view. Secondly, while it is desirable that the movable screen should not be made of a material easily soiled, or likely to change, error due to this is easily detected when the instrument is checked. Such a check should be frequently made to keep a watch on the condition of the accumulator and of the lamps, and of the contacts in the circuit. I always checked my instruments used in a horizontal position. It is convenient in calibrating the scale and in checking it, to turn the instrument on its side, with the perforated screen vertical. In 1895 I designed a photometer which was described in a paper contributed by Sir W. H. Preece and myself to the British Association.* The small cam and chain of the 1891 pattern were replaced by a system of levers.

This is shown in perspective in Fig. 93, and in side elevation in Fig. 94. In the latter illustration the lamp is shown on the right, and the movable screen, shown in full lines resting on a roller, is in the position of minimum illu-

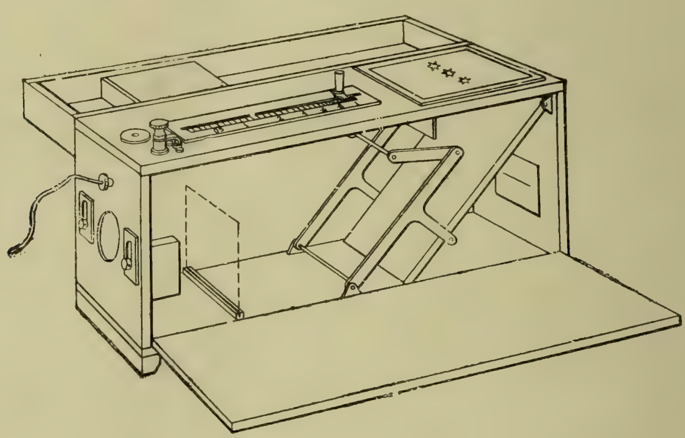


Fig. 93.—Second Pattern Trotter Illumination Photometer, 1895.

against a standard before going out for an evening's work, and generally again on coming home. Mr. Millar's third difficulty is entirely avoided by the use of a cam or a system of levers which expand the scale at the low readings.

*Second Pattern of Trotter Illumination Photometer.** — The instrument shown in Fig. 92 presented the disadvantage that it could only be

mination, the light just grazing along it. The handle by which it is moved is at the right-hand end of the straight scale. The dotted lines in Fig. 94, and the view in Fig. 93 show the screen and levers in the position of maximum illumination. The hook provided at the lower side of the movable screen held it against the roller when the instrument was turned on its side. The proportions of the system of levers were so designed that the scale, instead of becoming closely contracted at the low end, was considerably expanded, as is shown in Fig. 95. The scale was $5\frac{1}{4}$ in. (137 mm.) long.

* As little of Sir W. Preece's invention remains except the use of a horizontal screen and a small electric lamp, and since I can find no convenient name to describe a photometer having a perforated external screen and a moving internal screen, I must adopt the name by which it has generally been known, viz., the Trotter Illumination Photometer.

* *The Electrician*, Sept. 20th, 1895, Vol. XXXV.

Low Readings and Zero of the Scale.—It will be observed that the zero is absent. Considerable care is necessary both in the design and in the construction of an illumination photometer, to secure really low illumination such as 1/100 or 2/100 foot-candle, and it follows that feebler illuminations are yet more difficult to attain. It is, of course, possible to shut the light completely off the screen, and leave it in complete darkness, and so to arrive at zero, but that serves no useful purpose.

The range of such an instrument may be increased by using two lamps of different candle-powers, and by switching on either or both, three scales are sometimes employed, or three factors may be applied to a single scale. I used two lamps in my earlier photometers, but I am inclined to think that the increased complication, expense, and risk of bad contacts are not outweighed by the advantage gained.

box. Two small holes were drilled in this screen, one for each lamp. A white paper screen having a black horizontal line was fastened to the end of the box opposite the lamps. The movable screen being lifted out of the

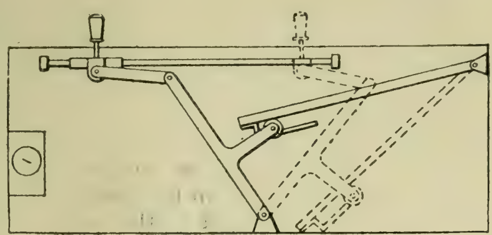


FIG. 94.

way, "pin-hole images" of the filaments could be thrown on this screen. When "horse-shoe" filaments were used the lamps were so set that the image of the limbs was nearly closed up and the thin dark line between the limbs was made to fall on the black

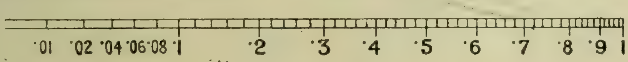


FIG. 95.

At the lowest illuminations the light nearly grazes the screen, and as Mr. Millar observes, the slightest displacement of the screen will produce a marked difference in the illumination. So far as the motion of the screen is concerned this need cause no objection if a well devised and well-made mechanism is used for connecting the pointer with the screen. But a more serious difficulty arises in the replacement of the lamp by another, for the filament of the new one should occupy the position of the old one, and with special exactness, in the plane of the minimum position of the moveable screen, or the scale would have to be re-calibrated.

Adjustment of the Lamp.—In all the photometers which I have made or have designed in detail, I have used simple straight filament lamps, miniature tube lamps, or "festoon" lamps, or "horse-shoe" or "hair-pin" lamps with good straight parallel limbs. In order to fix a new lamp in the true position, a sheet metal screen shown by dotted lines in Fig. 93 was set in a holder attached to the bottom of the

line. The images being magnified, considerable accuracy was possible. The clamping screws for the special lamp holders are seen outside the box in Fig. 93. The box was 1 ft. $3\frac{3}{4}$ in. by $5\frac{1}{2}$ in. by $9\frac{1}{2}$ in. high. (400 mm. by 140 mm. by 242mm.). The middle of the screen was about 11 in. (280mm). from the lamps. Several of these photometers were made by Messrs. Nalder Bros. & Co.

The Nalder Illumination Photometer.—During my stay at the Cape of Good Hope, 1896–1899, certain modifications of the perforated screen photometer were made by Messrs. Nalder Bros. & Co. A Hefner amyl-acetate lamp with an ingenious wind-guard was used instead of the electric lamp, and a curved movable screen was employed. I have never used this pattern, and was not favourably impressed by it. I was less inclined to criticize it after seeing the very useful work done with it by Mr. H. Fowler, who read a paper*

* H. Fowler, Proc. Inst. Mechanical Engineers, 1906, p. 867.

on 'Lighting of Railway Premises; Indoor and Outdoor.'

The origin of this modification seems to be that Messrs. Nalder Bros. & Co. distrusted the ability of a portable accumulator to maintain a sufficiently steady supply, and considered the question of a portable ammeter and a regulating resistance. Knowing that 2 per cent variation of light of a carbon lamp is produced by a variation of 0·3 to 0·4 per cent of the current, their knowledge of electrical measuring instruments showed them that a portable ammeter of this precision was out of the question. They therefore turned their attention to the use of a Hefner lamp, and appear to have succeeded in the difficult task of guarding its very sensitive flame against draughts. Considering the size of the flame and its proximity to the movable screen they seem to have made the best of a very difficult task. The manufacture of this pattern has been discontinued.

(*To be continued.*)

The Manufacture of Radium in Great Britain.

On Saturday, October 16th, the foundation stone of the works of the St. Ives Radium Corporation, to be built at Limehouse, was laid by Lady Ramsay. This Corporation will undertake the extraction of radium and uranium from the Cornish pitch-blende ore.

An interesting address was delivered by Sir William Ramsay, who drew attention to the increase in price of this valuable substance, and referred to the fact that an embargo had been placed on its exportation by the Austrian Government; in future, it will be made a principle that the radium produced in England will be supplied first and foremost for home consumption. In addition to its value for medical treatment, radium is of immense scientific importance, and has led to the fundamental modification of the views held by scientists on the constitution of matter.

It may also be remarked that although this substance has not yet found any direct application to lighting problems and illumination, we understand that some researches are in progress with a view to its utilization in connexion with the standard of light.

The Illuminating Engineering Society.

(Founded in London, 1909.)

During the past month the list of distinguished authorities in different countries who have kindly consented to give their support as Vice-Presidents and Corresponding Members of the Society has substantially increased. Among others the following have agreed to act in the above capacities:—Capt. V. Calzavara (Venice), Sir James Crichton Browne (London), Dr. W. W. Coblentz (Washington), Dr. M. Corsepius (Cologne), Prof. C. Feldman (Amsterdam), M. R. Granjon (Paris), M. F. Laporte (Paris), M. F. Lauriol (Paris), Herr A. Libesney (Berlin), Dr. B. Monasch (Augsburg), M. P. Rosemberg (Paris), Prof. J. Teichmüller (Berlin), Prof. Ubbelhode (Karlsruhe), &c.

Light in Custom and Superstition.

By Dr. M. Gaster.

(*Continued from p.* 632.)

Fascinating as the study of the worship of the heavenly light is in its manifold aspects and in the evolution it has gone through, no less fascinating is it to follow it in its travels under the sky, when it disappears from the sight of man, until it reappears in its heavenly abode. What happened to the god of light at the time of night or at the time when summer changed into winter? The light in fact, faded away, but it could not be dead; the gods could not die. That was their prerogative and the very essence of divinity. Human life is only a copy of the divine, and the fate which overtakes the one if it overtook man would certainly be considered as the best which could happen to him in his change from life to death. Both these sets of ideas and beliefs run parallel. The sun goes down and spends the night in a different world—the world of shades—beneath the earth, or in some special place. Few of the ancient religions have directly connected the sun with the region of the shades; but all agree in the belief that the abode of the departed is one bereft of every light, that it was one of darkness more or less relieved by flames. The Egyptians, whose views on the immortality of the soul and the life after death are quite their own, identified that of the man with that of the sun. The highest aim of the worshipper has been to become as one of the gods, notably to personify Osiris the sun god. They described minutely the travels of the sun under the earth during the night time; they could not ignore the fact that the sun rose every morning exactly in the same spot in the East whence it had risen on the previous day, and set again in the West. How then did the sun come back to its old starting point? The natural answer was that the sun travelled under the earth from West to East. The question then was, what kind of land was it that the sun traversed and illumined during the night. To this the ancient Egyptians replied, it was the land of the departed. It is not here the place to describe in detail this transit of the sun in its celestial boat, accompanied each hour by other divinities and marking its passage through the nether world by constant changes, encompassing many dangers and coming out victorious in the morning in spite of the attacks of monsters and demons. To the sun, then, the dead person was likened, and a whole system of funerary customs arose in Egypt, all intended to ensure the safe passage of the dead to the abode of bliss—for in such they they believed. For that purpose the dead was likened to the sun Osiris; he is the sun incarnate, and he plays the role of the sun-god in the encounters with the underworld monsters and evil spirits, bent on his destruction; he is armed and assisted by moral maxims and magical formulæ, and with their aid he passes through the various gates leading from one hall to the other until he comes before the final judges to be condemned or saved. All the while he is personifying the god until it is decided whether he deserved punishment or not. And then he proceeds to the fields in which the sun shines during the night and light is never extinguished. In order to ensure the safety of the dead the Egyptians spared no trouble, and placed in the grave all that was considered necessary to safeguard the passage of the departed man who was to become in his own person the Sun-God.

If we turn to other nations we shall find the same belief of the sun travelling

under the earth during the night and sojourning there during the winter months, a kind of shade in the abode of shades.

The best proof for this belief was seen in the hot springs, which must derive their heat from the rays of the sun that passed along their sources in the night and warmed them. But this was a land of bliss upon which the sun shone, and it was granted but to few to reach it. The very absence of the sun and of every form of light, the dark gloom and obscurity, was, on the contrary, the special feature of the abode of the shades to which the dead descended in the religious systems of the old nations. To this was joined the belief of burning flames, of pitch and brimstone, so soon as the idea of punishment after death had taken a deep root in the consciousness of the nations. A rough philosophy demanded some sort of punishment for evil deeds committed in this life and not atoned for before death. And the volcanoes with their fiery lava gave substance to the belief in the existence of subterranean fires which from time to time would also make eruptions into the upper world. Inside the bowels of the earth there were the great smithies of the fallen gods, and from a fallen god he soon became a fallen spirit, an evil spirit, whose natural element was the flame, and whose functions then were to use the flames for the punishment of those who had followed his example and had also fallen from heaven. The descents into the nether world, as described by Vergil and in the apocryphal tales of St. Peter and St. Paul or of the Irish Saint Dunstan, allow us to follow up in the literature of the West the change in the conception of that world of shades and darkness which becomes transformed into a place filled with the qualm of the burning fires. Here the light is extinguished, and the fire, an instrument of torture, is no longer a manifestation of the divine.

But the real abode of the dead was dark, and this darkness had to be dispelled, hence the old-world custom of giving some form of light as company to the dead, to light up their path and to dissipate the darkness. Nothing is so common, therefore, in the ancient grave as the lamp. It is found over the whole of the ancient Roman Empire, an everlasting symbol of the desire to comfort the dead by lighting a lamp in the very place of their dismal rest. The light of this world should follow them. They should not be left without the cheer and comfort of this world. No sooner is the earthly life extinguished than a new light is lit, which is at the same time the symbol of the departing soul and the light on its path. Even the grave was not to be left dark if human love could prevent it. And thus the burning of lamps and many other ceremonies of a funereal character arose, in which the kindling of lights played an important part. At the death of a man in many households a lamp is lit which is kept burning for a least a week or a month, and also for the whole year of mourning. On the anniversary of death the lamp is again annually lit. In many crosses on Eastern churchyards a small recess is cut for the lamp which is kept burning there for the dead and at the anniversary of death, and especially on the day of the dead. The Church has established a special day (Feast of All Souls) in which prayers are recited for the repose of the souls, and for each soul a lamp is lit, the symbol of the soul and a guide in the nether world.

Nor is it a far cry from the simple lamp of the ancient Romans to the sumptuous wax candles round the bier of the defunct or to the "chapelle ardente" which now surrounds the earthly remains of the departed in the ritual of some churches. It is only a matter of degree; the substance, the underlying principle is the same, though here also it has almost been forgotten. It is to light up the darkness created by death and to provide the dead with that divine light, the symbol of their essence, and at the same time a protection in the world below. In some places they put lighted candles upon the coffin and keep the light burning until the body is interred; and then after the burial the light is not extinguished; on the contrary, it is accounted for a pious action to keep it burning. Thus

the light accompanies man to the other life, and care is taken that it be with him as far as human belief and human love can provide for it.

Starting from these customs, there has arisen another series of ceremonies connected with the Feast of All Souls. The departed return also to this world at set times, and on that occasion, among other things prepared for them, are lighted candles and lamps in the huts or houses—nay, even in the churches, on the graveyards, and on selected spots laid out for their reception and for their satisfaction. The dead have a respite from the harrassing tortures beneath, and moreover, they bring blessing to those who honour their coming back. This practice is almost universal. It is practised among the aborigines of America as well as among the Japanese with their feast of lanterns; the Chinese and the people of Cambodja know it and practise it; and to a large extent it is kept among the modern nations of the West, in France and Italy, in the Tyrol, and Germany, and also in the North and among the Russians.

On that day a peculiar custom prevails among the nations of the South-East of Europe. They fill eggshells with oil, put a wick in it, and send the eggs thus filled and lighted down the current of a running water. They call it the day of the Rahmans, *i.e.*, the day of the pious dead, to whom they send these lamps for comfort and for salvation. This connexion of light with the shades of the departed leads insensibly from faith to custom, and from custom, no longer understood, to superstition, and with this I shall deal in the concluding portion.

Extension of Electrical Street Lighting in Berlin.

A RECENT visit of the Deputation of the Corporation of the City of London to Berlin, and their recently published report, has drawn general attention to the well-known system of high-pressure gas lighting in that city. It will be recalled that it was suggested in this report that in future extensions only incandescent gas lighting would be employed in that city (see *Illum. Eng.*, London, Aug., 1909, p. 528). We have, however, received from the *Berliner Elektricitäts-Werke* some particulars of the extension of the existing system of electric street lighting previously used in the Leipzigerstrasse and the Friedrichstrasse to the Leipziger Platz. The new arc lamps are credited with 3,000 H.K. each, and are stated to raise the illumination of this important centre of traffic to that demanded by the chief thoroughfares of the city.

The Local Government Board and Illumination.

IN a recent number of *The Electrical Times* reference is made to the advice of the Local Government Board to the Yarmouth Town Council on the subject of public lighting. In this connexion it is asked, "How does the Local Government Board know that the lighting will be improved? Where are their data, who is their authority, where do they keep their photometers and instruments?"

Where indeed? In the Editorial remarks in the September number of *The Illuminating Engineer* attention was called to this subject, and it was suggested that, if the Local Government Board contemplate taking action in such matters their right course is to establish an efficient and impartial technical department, capable of dealing authoritatively with questions of illumination, where reliable advice and data might be available.

It is gratifying to find that the need for such impartial expert advice is now coming to be widely recognized and commented upon in the technical press.

A 14th Century Standard Specification for Wax Candles.

At the present time, when the number of illuminants is growing daily, the need for some more precise regulations defining their quality and distinguishing good material from bad, is seriously felt. There are already in existence in the chief European countries standard specifications relating to carbon filament electrical glow lamps, and the development of the metallic filament lamp, and its subsequent cheapening, has led to the consideration of the possibility of framing a similar specification with regard to lamps of this nature.

Some of the following particulars, which we have received from a correspondent (Dr. B. S.), who has made a special study of the records of ancient conditions of illumination in London, back to the times of King Richard III., contain very instructive suggestions in this connexion. Readers of this journal will be familiar with other contributions of our correspondent in past numbers of *The Illuminating Engineer* (Feb., 1909, p. 87 ; April, 1909, p. 272 ; May, 1909, p. 316). in which the progress of methods of street-lighting from the days when London "was melancholy after curfew," when no lights were to be seen in the streets save in the winter evenings between Allhallow's Eve and Candlemass, and when each citizen of London was ordered by Sir Henry Burton, under severe pains and penalties, to hang out a lantern between the hours of six and eleven at night, is dealt with. Since that time we have seen the gradual evolution of lighting through various stages, and the exploitation of tallow, oil, gas, and electricity. But at the date to which the present records refer candles were the only means of illumination in common use.

Naturally, therefore, it was to the citizens of that age as vital a matter to see that their candles were genuine as it is to the public of the present day to see that their electric lamps or incandescent mantles are of good quality.

In addition, we must bear in mind the effect of the monopoly existing in those times. So long as a healthy competition prevails, there is usually continuous improvement. But the granting of Royal Charters and the establishment of a monopoly in candles removed this incentive and led to various abuses.

According to the Royal Charter of 1483, the price and quality of wax candles was left to the direction of the Guild of Waxchandlers, and in the subsequent year a grant of arms was also given. These two documents are reprodcued in facsimile in Figs. 1 and 2. For the benefit of readers our correspondent has also made the following abstract of the contents of the charter :—

Charter by King Richard III. to the Waxchandler's Company.

(Abstract.) See Fig. 1.

[In Latin]

Ricardus (III.), King of Anglia and France "grants to the Maister, Wardeyns and the Comynwaltie of that Mistere or Craft of the Waxchandlers of London" certain privileges. He grants to those who worked at the craft of the Waxchandlers "that the Maister, Wardeyns and Comynwaltie, and their successors shall have a perpetual succession," *i.e.*, shall be onwards considered as an organised gild. And he grants "that they and their successors shall be elected, named, and called by the name of the Maister, etc......of that mistere or Craft of Waxchandlers of London." He grants that "they may make laufull and honest

congregacionys to the statute and ordinances for the profits of the same craft." The humble standing of the Company is mentioned at the end of the document where it is stated that "the extent of their licence in mortmain is—five marks," or 3*l.* 13*s.* 4*d.* a year.

¶ The Charter is dated 16th February; I. Richard III. (*i.e.*, 1484). It was renewed several times; June 7, 4 and 5 Philip and Mary, 2 Eliz., and 2 James I., by inspeximus to 15 Charles II., which is the acting one.

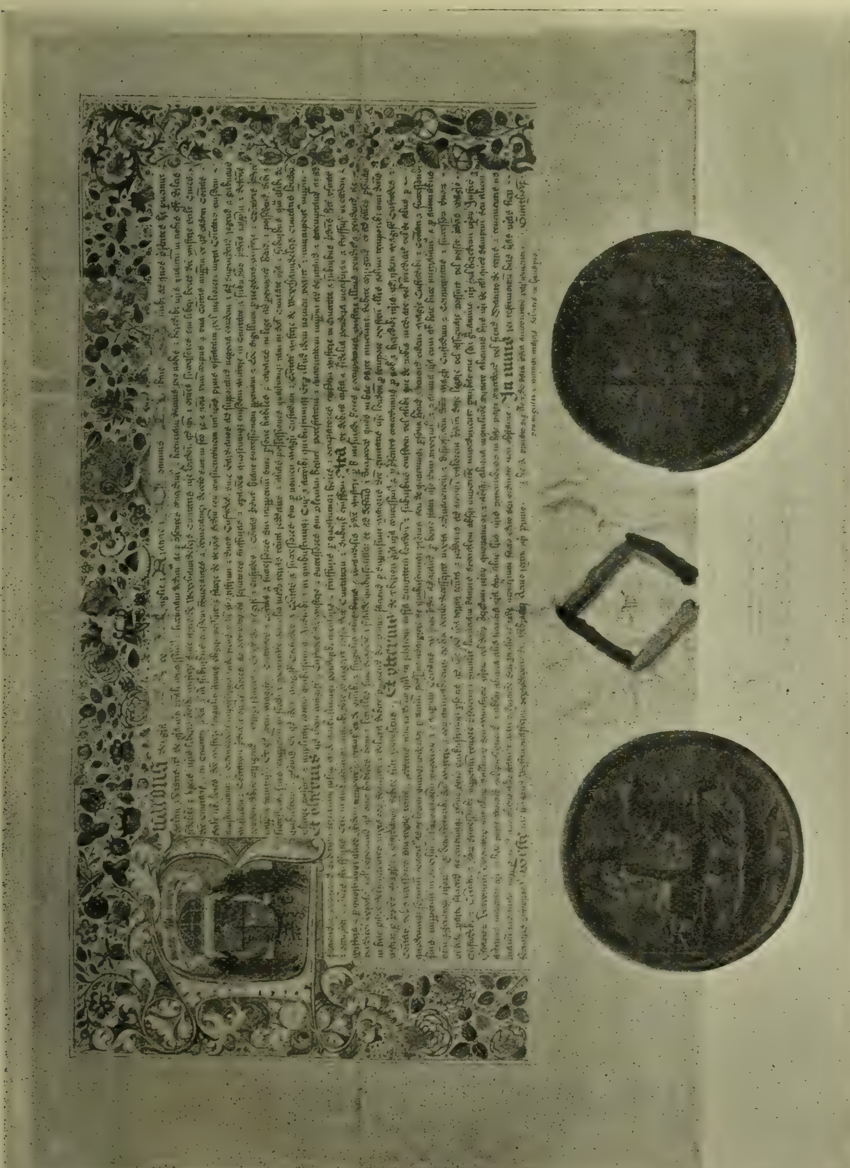


FIG. 1.—A Facsimile of Charter granted by King Richard III. to the Worshipful Company of Wax-Chandlers of the City of London.

The following is an exact transcript which our correspondent has kindly made of the grant of Arms referred to, the original spelling and phraseology being as far as possible exactly reproduced :—

Transcript of the Grant of Arms to the Waxchandler's Company by Richard III.

(*See page* 737.)

TO al true Cristen people thies presentes fres Reding hering or seing I Thomas Clarenceu principal herald and King of Armes of the south parties of this Realme of England other wise called Thomas holme Knyght send due and humble recõmendation and greting as it apperteigneth in oure lord god eu'lasting ffor somoch as I understand for certeyn that every Craft and ffraternite withinne the Kinges moste Royal Citie of london called his Chambre compasse study devyse and ymagyn with theire besy cures and budelaired devoires and diligences and such psonnes namely as be linially descended from noble blod compelled therunto by verry cours of nature the moste convenient and moste honorable weys and meanes to theim possible for to exalte and preferre theire craftes and ffraternities to honeur and nobley and to as excellent lande and recõmendatõn as by theire myndes can be thought or contreyued to rhentent that eu'y psone entring or comyng to their craftes and ffrat'nities hering of theire sadde and laudable vertuoux and cõmendable dispositions and opiniones shuld the rather enforce and applie theim self effectually with al possible diligence towardes the mayntenaunce and supportacõn and longe continuannce of the fame to the laude and preysing of God thond of the King oure sou'aigne lord of this his Realme and Citie aforsaid and of the said crafte and fraternitie Amonges Whome I the said Kinge of Armes note and appointe at this tyme specially the god sadþ worshipful and weldisposed p'sonnes the maister and wardennes of the ful honorable craft and ffraternitie of wexchanndeleres of the said Citie that is to say Thomas Stone Citezen wexchanndeler and maister of the said craft Thomas 2Bett and Jojn Asshe citezens wexchanndeleres and wardennes of the same craft for the tyme beeing with al the holl bodi of the same I the said King of Armes for the tendre zele and inward affection that I bare toward the said craft and ffrat'nitie ffor the p'ferrement and encreesse therof to honeur and nobles have goven & granted unto theim the Armes herafter following as in the ijgyn depicte more playnly appereth—that is to say thei bere Asur thre morteres royal upon a cheuerõn silid thre Roses goules seded gold The creste upon the helme A mayden Kneling amonges dyu's ffloures in a Surcote cloth of Gold ffurred with Ermyn making a garlond being in hir hand of the same ffloures sett withinne a wreth gold and goules The mantell Afur furred w^t Ermyn. Which Armes by thauctoritie and power to myn office annexed and attributed I the said King haue devised and ord'uned to & for the said crafte and ffraternitie of wexchanndelers to theim that now be and to theim herafter shal be yur success in signe and token of nobles for eu'more. To haue and to hold occupie and reioice the same Armes peasiblie and vouablie to the said maister and wardennes and their Successours wexchanndeleres at their pleafs w^toute impediment interuptõn lett or empechement by vertue of my said graunt for euermore. In witnesse wherof I the said King of Armes to thies p'sentes signed with my hand haue do put my seal of Armes of Auctoritie yoven at london the third day of ffebruary the second yere of the Reigne of oure soveraigne lord Kinge Richard the third.

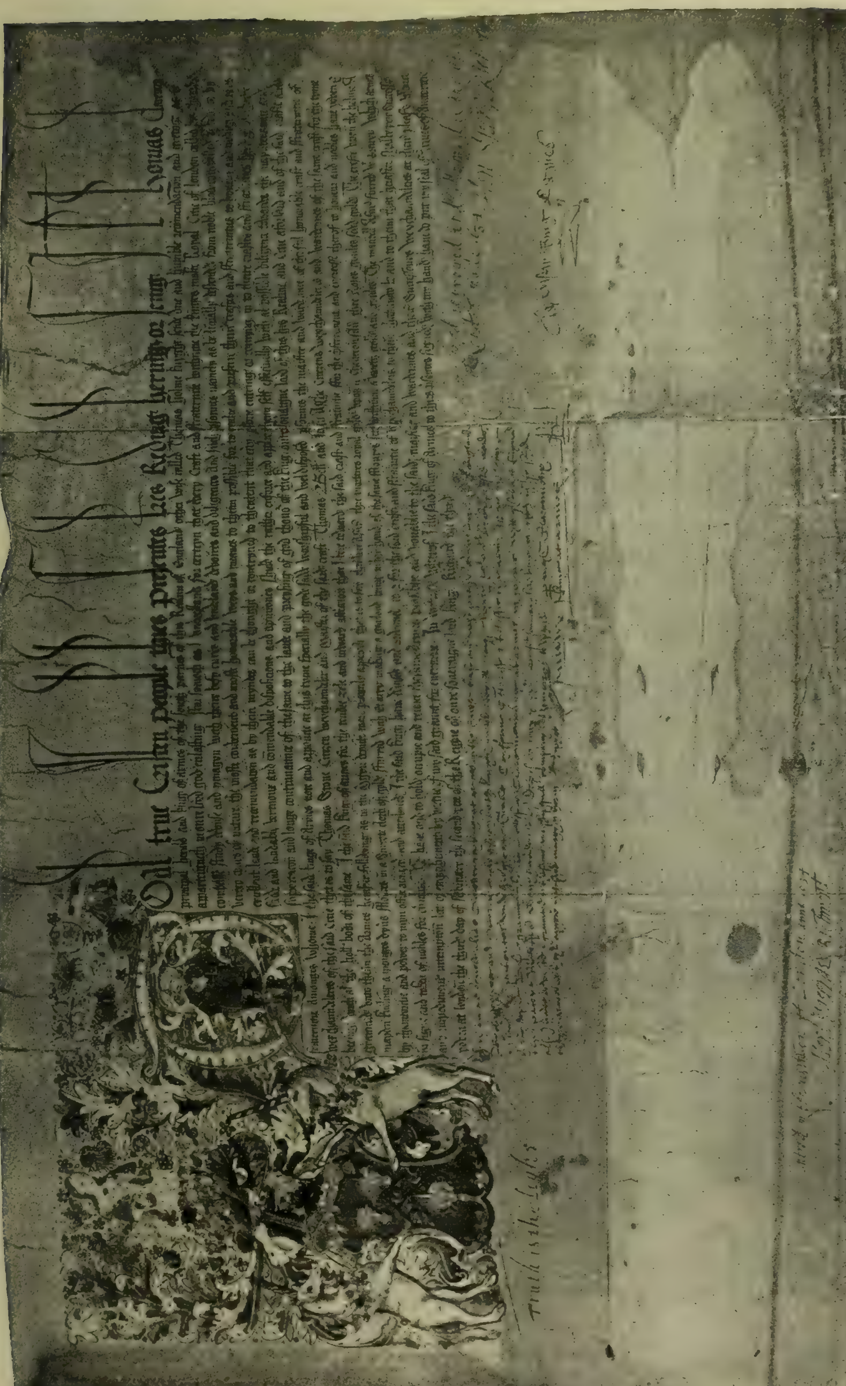


FIG 2.—Facsimile of Grant of Arms accorded to the Worshipful Company of Waxchandlers by King Richard III. in 1485

The result of this monopoly, our correspondent states, was that very indifferent progress in lighting was made, and that London, for over 300 years, was probably behind every great European city in street lighting. When at length an ever-increasing population rendered more efficient methods of illumination a *sine qua non*, materials for lighting other than wax were sought, and eventually found in tallow and oil. At the same time the personal obligation of each householder to provide street lighting ultimately came to be transferred to municipal authorities.

Another grievance which seemed to have been felt at a very early period was the tendency to adulteration in candles, the only known illuminant, which presumably injuriously affected their practical utility and illuminating value. The following protest on the subject shows very clearly that the city was in earnest in the matter :—

Ordinance of the Waxchandlers, 32 *Edward III.*, A.D. 1358. *Letter-Book G, fol. xcii.* (*Latin and Norman-French.*)*

[In Latin.]

"This ordinance was made in the time of John de Stodeye, Mayor, at the Feast of the Nativity of St. John the Baptist [24 June] in the 32nd year.

[In Norman-French.]

"For redress of many grievances and damages that divers folks have in many cases suffered in the City of London, as to the which remedy has not been ordained heretofore, the Mayor, Aldermen, and Sheriffs, with the assent of the good folks of the Commonwalty, have ordained the Articles underwritten, for the profit of the common people.

"In the first place—it is ordained that all the Waxchandlers who are dwelling within the said city, and in the suburb, as well freemen as foreigners, who shall make torches, cierges [wax-tapers] torchys [torchettes, *i.e.*, a variety of the torch], priketz [wax-candle, for placing on a "perk" or spike of metal], great candles, or any other manner of waxchandlery, for sale, shall make such torches, cierges, torchyz, priketz, and all other things which pertain unto their trade, of as good wax within as without, making the whole thereof of the same wax ; and that they shall not put into their wykes any fat, code [cobbler's wax], rosin or other manner of refuse, nor shall they use old wax and worse within, and new wax without, And that they shall not make their wykes, which they put into such manner of work, of excessive weight, so as to be selling wyke for wax, to the damage, and in deceit, of the common people ; but let their wyke be in accordance with the quantity of wax, as it reasonably ought to be. And if any waxchandler shall from henceforth do to the contrary of the ordinance, and of the same be duly convicted, the first time, all the torches, cierges, torchyz, priketz, and other waxchandlery, that shall be found in their possession made, shall be burnt before the door of him who shall have made the same, at the place where he dwells, and his body shall be committed to prison ; until he shall have made fine to the Commonalty, at the discretion of the Mayor and Aldermen, for such manner of deceits and falsities committed, to the damage of the common people and the scandal of the said city.

"And on a second default, let the torches and other works be burnt as is before ordained, and his body be put upon the pillory.

"And the third time, he is to foreswear the City, and all torches and such work.

"And that this ordinance may be the more surely kept and maintained, let there be forthwith chosen two or four of the most lawful folks, of the said trade, who shall be sworn before the Mayor and Aldermen, lawfully to present all the defaults that they find in their trade, from one day to another. But in case any reputable man shall come to the aforesaid waxchandlers, and shall wish them to make torches, torchiz, prykes, cirgez for mortuaries, or other large candles, of old and new

* Riley, 'Memorials of London and London Life,' 1868, p. 300-301.

wax, mixed together for his own use, the waxchandlers may have the same made at the wish of the owner, without hindrance thereof, so that he make one sale thereof, on the pain aforesaid."

As something very closely akin to a "standard specification," this document is of considerable interest. And the appointment of "four of the most lawful folks of the said trade" to act as a committee of investigation seems to be an appeal to expert opinion which might sometimes be imitated with advantage at the present time. At the same time, it is interesting to observe that the construction of candles otherwise than in accordance with the specification and for a given object, was not absolutely prohibited, provided it was at the request of a "reputable man" that such candles were made and for his personal use. It was merely the issue of inferior goods composed of a different material to that ostensibly offered that was attacked.

This code was renewed and enlarged in 1371 by the petition to the Court of Aldermen of the City of London for leave to choose searchers for bad wares and for approval of by-laws then submitted for the regulation of the craft. These are the words of the petition :—

Articles for the regulation of the trade of the Waxchandlers. 45 *Edward III.* A.D., 1371. *Letter-Book G, fol. cclxxxiii.* [*Latin and Norman-French.*] *

[In Latin.]

"On the Thursday next after the Feast of St. Martin the Bishop [11th November], in the 45th year etc., came here the reputable men of the trade of the waxchandlers, and delivered to the Mayor and Aldermen a certain petition, in these words :—

[In Norman -French.]

"To the honourable men, the Mayor and Aldermen of the City of London, shew the good folks, the Waxchandlers of the said city, that their trade has been badly ruled and governed heretofore, and there still is great scandal unto all the good folks of the said trade and of the City, because that they have not masters chosen of the said trade, and sworn before you, the Mayor and Aldermen, as other trades have, to oversee the defaults that are committed, in their said trade, and to present them to the Mayor and Aldermen of the said city. And for this reason, very good Sirs, the said good folks do supplicate your gracious Lordships, that you will be pleased to grant unto the said good folks, that they may choose from among them four good men of the said trade ; and that they may be sworn before you, most honourable Sirs, to have surveillance of all the defaults in their said trade, and to present them before the Mayor and Aldermen for the time being ; that so, the offenders may be punished according to their deserts. And that the points underwritten may be granted unto them, and enrolled in the Chamber, before you, for the common profit of the said City.

"In the first place—that no chandler of the said trade shall make any torches, cierges, prikettz, or other candles, of wax, mixed with rosin and code, but only of good wax and wick. And that, if any chandler of the said trade in time to come shall make torches, cierges, prikettz, or other candles of wax, for sale, that is mixed as aforesaid, and that may be found and proved by the Masters of the said trade, before the Mayor and Aldermen, to be not proper wax or wick [lymyoun] the person who shall be so convicted shall pay to the Chamber the first time 6*s.* 8*d.* ; and the second time to the said Chamber, 13*s.* 4*d.* ; and the third time to the said Chamber, 20*s.* ; and the fourth time, he shall foreswear the trade for ever.

"Also,—that every chandler of the said trade, within the franchise of London, shall receive for the hire of round cierges for funerals, one peeny per pound, the party also paying the chandler for the waste of the said candles, and a reasonable sum for the hire of the herces [the iron framework like a harrow (hercia) on which the

* Riley, *ibid.*, p. 358 ff.

candles were arranged] and candlesticks requisite for the said cierges.

"Also,—for squared cierges, within the said franchise, for every piece one penny; the party also paying the chandler for the waste.

"Also,—for the hire of torches, for every pound one penny; the partly also paying the chandler for the waste.

"Also,—if any person shall bring wax to a chandler, to make torchez tortiz, prikettez or perchers, candles, or cierges for women at Candlemas, the Chandler shall take for every pound of wax one halfpenny for the making; and he who shall have it made, must bring the wyke, or else pay for the wyke.

"Also,—if any man shall bring wax, to make round or squared cierges thereof, the chandler shall take for every pound one halfpenny, for his trouble.

"Also,—the said good folks do pray, that every chandler of the trade within the said city may have a mark, and that he put it upon the torches, tortiz, and cierges, which he makes; that so, if any default shall be found in the same, the person may be known in whose work the default is, and be chastised for his offence against this Ordinance; and that such torches, tortiz and cierges, as are not impressed in manner aforesaid, may be forfeited to the Chamber."

In a sequel in Latin, it is added that Waulter Rede and John Pope were in the same year "chosen and sworn to oversee the said craft, and the defaults from time to time found to present to the Mayor and Aldermen, &c."

The extended form of the ordinance seems to approach even nearer to modern requirements in some respects. Thus the recommendation that "every chandler of the trade within the said city may have a mark, and that it be put it upon the torches, &c.," is surprisingly similar to the trade mark of to-day and in line with the suggestion that every incandescent glow-lamp should be provided with an authoritative mark specifying what it ought to do, and that prosecution should follow if the claims of such a lamp are proved to be clearly fraudulent.

The infringment of these ancient by-laws occasionally led to a revocation of the Royal Charter [*i.e.* by James's Proclamation of 10 July, 1621 (Brit. Mus. 506 h. 12 (87), but this did not immediately mend matters, as the tallow chandlers, who were now in competition with the waxchandlers, also abused their privileges.

However, it was the beginning of a better order. As the need for improved lighting increased, street illumination became a matter for *municipal consideration* instead of what it had hitherto been, a *personal obligation*, manufacturers now vied with one another to *facititate* the more extensive lighting that became necessary.

It is not surprising to find, however, that a little later we meet with another development (not altogether unknown in modern times) namely the obstructive attitude of the older established vested interests towards the newer methods of illumination. The introduction of tallow candles and oil was soon resented by the waxchandlers, and we find the following petition being presented :—

"*Reasons humbly offered to the Hon. House of Commons by the Master, Wardens, and Company of Wax Chandlers, London, for the suppressing of all Mould Candles.*

"That by an Act made in the Eighth Year of Her Present Majesty's Reign, Intituled, An Act for laying certain Duties upon Candles towards Raising a Supply to Her Majesty for the year 1710, a Duty of 4*d*. per Pound is laid on all Wax-Candles.

"That for many years past, and before the making the said Act, many Private Persons have made great quantities of Mould-Candles, (which very much resemble Wax-Candles, and are frequently taken as such) but since the making the said Act, and to evade the Payment of the said Duty, many Hundred Dozens of Moulders have been made for making of Mould-

Candles, which are never brought into or sold in Trade, whereby the Revenue intended by the said Act must inevitably sink in Proportion to the great Quantities of such Mould-Candles, so privately made, which prevents and destroys the Making and Sale of Wax-Candles, upon which the said Duty is laid.

"That it is intended, that an Additional Duty be laid upon all Wax-Candles.

"But if the making of Mould-Candles be continued and increased, as there is no Reason to doubt but it will, for which no Duty is paid, the making of Wax-Candles will be destroyed, and the Revenue already laid, and intended to be laid, will sink very much below the Sum it was designed to Raise, and cause a great Deficiency.

"It is therefore Humbly prayed, That such Private Practice of Making all Mould-Candles may effectually be suppressed by some Good and Effected Law to the contrary."

This, however, was their last effort. The influence of a monopoly, referred to at the commencement of this article, was broken by the introduction of tallow, oil, and eventually gas as rival illuminants. This subsequent development will be dealt with in a further series of articles, and we shall see how the responsibility for public lighting changed hands and was gradually shifted from one authority to another.

One need of the present time was, however, foreshadowed even by the experiences of the waxchandlers, namely the need for a central body to supervise the public lighting of a city, though naturally the creation of such a central authority was a simpler matter when candles were the only illuminants available. This, too, will form the subject of further study.

The Theory of Vision and Colour Perception.

A LECTURE on the above subject was delivered by Dr. F. W. Edridge Green at a meeting of the Optical Society on October 21st. Reference has already been made in these columns to the views held by Dr. Edridge Green on colour vision (*Illuminating Engineer*, March, 1909, p. 210).

One of the most interesting suggestions by the lecturer was his interpretation of the part played by the visual purple. When Kuhne discovered this substance in the eye it was thought that a great step had been taken towards the solution of the problem as to how vision was accomplished; subsequently, however, it was pointed out that this substance did not occur in the cones in the retina, which are believed to play an important part in vision, and von Kries, a German physiologist, brought forward a theory of vision based on certain qualities attributed to the rods and cones respectively. This theory has found wide acceptation.

Dr. Edridge Green, however, points out that under certain conditions the visual purple can be seen to exist *between* the cones, and he suggests that vision is accomplished by impulses created by the stimulation of the ends of the cones by the visual purple; the rods, on the other hand, are concerned only with the formation and distribution of the visual purple, and probably do not possess any power of perceiving light as has previously been thought. The impulse transmitted to the brain, stimulates a visual centre, producing the sensation of light, and then another centre leading to the sensation of colour.

Dr. Edridge Green exhibited a series of pictures illustrating the mistakes made by colour-blind individuals.

In the discussion which followed the paper Dr. Rosenhain discussed the lecturer's method of testing colour-blinds in some detail, and Mr. S. D. Chalmers compared the mechanism of the retina and the nerve-connexions to a tuned electrical circuit. Mr. J. S. Dow, as a representative of *The Illuminating Engineer*, referred to the important bearing of the theory of the retina on photometry, and mentioned some experiments of Prof. J. G. Burch on dark-adaptation as being apparently explicable by the lecturer's theory of the behaviour of the visual purple.

The Relations between the Units of Illumination in Different Countries.

By Dr. B. Monasch (Augsburg).

On July 1st of the present year the Bureau of Standards in Washington began to express their photometrical results in terms of the new "international unit," which is defined as follows:—

1 pentane candle = 1 American candle = 1 Bougie Decimale = 0·90 Hefner candle.

In consequence of this decision the table worked out by the author connecting the units of intensity of illumination at present used in different countries, namely the Lux, Hefner-foot, Candle-foot, Candle-metre, Carcel-metre, Bougie-metre (see *Illuminating Engineer*, Lond., vol. i. p. 151, 1908), requires revision; for the relations between the units of light in use in the countries referred to, on which this table is based, are now different.

The corrected table is therefore as follows:—

Results expressed in	Factor for conversion into the desired Unit.				
	1. Hefner-meter (German Lux)	2. Hefner foot.	3. International candle foot.	4. Intern. candle meter ,, bougie meter ,, Lux.	5. Carcel meter.
1. Hefner meter (German Lux) ...	1·	0 0929	0·0837	0·9009	0·093
2. Hefner foot	10·76	1·	0·9009	9·71	1·001
3. Intern. candle foot	11·95	1·11	1·	10·76	1·034
4. Intern. candle meter ... ... ,, bougie meter... ... ... ,, Lux	1·11	0·103	0·0929	1·	0·104
5. Carcel meter	10 75	0 9986	0·966	9·61	1·

School Illumination.

Good light is of the highest importance where children are working, and the effects of improper and insufficient lighting on the youthful eye are well known to be extremely pernicious. Notwithstanding, one rarely finds a school properly equipped for artificial lighting....It is about time that school committees were brought to realize that the eyes of the children committed to their charge are of more importance than the decorative scheme of the schoolroom or the alleged artistic effects of the lighting fixtures.—*Domestic Engineering*, September, 1909.

The Development of Gaslighting in Berlin.

By a German Correspondent.

The writer attended recently the Forty-eighth annual meeting of the German Verein von Gas- und Wasserfachmännern, during which a lecture was delivered illustrating the remarkable development of the gas works in the German capital. According to this lecture the yearly production of all gas works in Berlin has risen during the last decade from 122 million cubic meters to 253 millions—in other words, it has more than doubled. The gas consumption per head of population in 1908 has (although the actual population has also much increased) assumed the remarkable figure of 120 cubic meters; ten years ago it was only 70.

The introduction in 1901 of a comparatively low price for gas for cooking and heating purposes is probably largely responsible for this development. Interesting, too, are the advances made during the last decade by gas lighting in Berlin's public streets and squares; this development was more or less forced upon the gas industy by the victorious progress of the electric arc lamp. The number of gas burners in public use has not much increased during this period, viz., from 27,000 to 32,000. But the *intensity* of light has greatly increased. While the above 27,000 burners produced an actual light of 1·8 million Hefner candle-power, the 32,000 flames at present in use furnish a total light of 4·7 million candle-power. What this means, as regards the artificial lighting of Berlin's streets, can be seen from the fact that to-day we obtain 0·44 candle for each square meter as compared with 0·192 ten years ago; our streets are thus now lighted more than twice as well as in 1898.

And yet, in Berlin, only 6 per cent of the total gas production is used for public lighting which, compared with other German and foreign cities, is a rather low percentage. This 6 per cent could not, of course, produce such a powerful light as it does (in comparison with which foreign large cities in America and elsewhere appear to be almost gloomy) if compressed gas had not been introduced on such a large scale. The lamps operated on this system consist of three incandescent burners mounted within one lamp, consuming in all 800 liters (211 gallons) per hour. By using compressed gas the luminous value of such a lamp is considerably increased, and its power approaches very near to that of an electric flame arc lamp. As some of the principal streets of Berlin, for instance, the famous Friedrichstrasse, were fitted last year with the new, very efficient arc-lamps, using specially prepared "alba" carbons, the competition between these two efficient and powerful types of illuminants has become rather keen. No judgment can be passed as yet in favour of one or the other system. It can only be stated that the high-pressure gas lighting has done very much for the lighting of Berlin and other German cities.

Two or three years ago the lighting of Berlin's most crowded square—the Potsdamer Platz—the traffic in which resembles that near the Bank of England in London, was the object of much admiration. Some streets issuing from it, however, are now lighted with compressed gas, producing a lighting effect comparable with that of the powerful arc-lamps of the square itself. It is even said that in the German capital too much is done in the way of lighting. The stronger the public lamps in use the greater the tendency for shop keepers to use intense lights for their windows in order that the attention of passers by may be attracted by their own show windows and not by the street lamps. A gloomy street

may therefore even be preferred by a salesman, as his brilliantly lighted shop stands out better than it would in a brightly illuminated street.

The high-pressure lamps referred to receive their gas from special plants, of which there are three in Berlin; two others are in course of construction. The gas for these three compressor plants is produced in quite a number of works, of which two are closed at the present time in order to make room for strictly modern and enlarged plants. One plant of specially up-to-date design is that at Tegel (a northern suburb of Berlin). This was originally intended to produce 250,000 cubic meters a day, but is now furnishing 340,000 cubic meters, or about 75,000,000 gallons, while arrangements are being made to permit a daily production of 450,000 cubic meters, or 119,000,000 gallons. A similar large plant will be erected at the river Spree in the eastern district of Berlin.

In conclusion, it may be said that the length of the entire piping in use in Germany was 1,311 kilometers at the end of the last year, as compared with 900 in 1898. It at present extends about the distance from the most north-eastern city, Königsberg, on the Russian border, to Münich—a diagonal line across the German empire.

Gas Illuminated Concrete Advertisement Signs.

We are familiar with types of gas-lighted signs which are made of metal pipe-work, out of which the gas issues by numerous small orifices. Such designs have frequently been employed for festive occasions in the streets, and the trembling gas flames have sometimes a certain decorative value which is claimed to be less readily obtained by a steady unwavering light, such as is furnished by electric glow lamps.

An interesting modification of this method is described in a recent number of the American *Gaslight Journal*. Porous logs of some concrete material moulded in various devices have been used in the open fire-place. More recently, however, illuminated signs have been constructed by utilizing more or less porous cement which the gas is allowed to enter and from which it emerges through innumerable small holes. The fine jets obtained in this way are said to be a great improvement from the decorative standpoint; it is also possible to mould the concrete into any desired shape and produces designs of a much more artistic character than can readily be produced by iron-work.

An Example of Spectacular Lighting in Frankfort.

The illustration on the opposite page, for the use of which we are indebted to the courtesy of the Editor of the *A.E.G. Zeitung*, refers to the illumination, carried out by the A.E.G., of an exhibition hall at Frankfort-on-Main, at a recent exhibition held in that town. A special feature of the arrangements is the use of twenty flame arc lamps, each credited with about 4,000 H.K., which are distributed high up round the interior of the dome so as to throw a strong light down in the auditorium, and yet not to have any dazzling effect.

In addition special effects are produced by outlining the galleries by a series of miniature metallic filament lamps, each spaced 12½ centimetres apart and each yielding about 2 H.K.; the wreaths composed of glow lamps of this kind appear practically continuous. It is stated that as many as 20,000 miniature lamps were thus installed. A total intensity of approximately 400,000, and a total power consumption of 360 kilowatts, are stated to have been utilized.

It is suggested further that the accompanying illustration, while showing the nature of the distribution of the lights, does not do justice to the colour effects, which received special attention in the general design.

Exhibition Hall in Frankfort-on-Main, Germany, lighted by flame arcs and miniature glow-lamps. By the courtesy of the *A. E. G. Zeitung.*)

"Standardization."

Inaugural Address of the President of the Association of Engineers in Charge, Mr. Henry Adams, October 13th, 1909.

On October 13th, the inaugural address of the new President of the Association of Engineers in Charge was delivered by Mr. H. Adams, who selected for his subject 'Standardization.'

The earliest standard he pointed out was probably the unit of length, but down to 1824 the only legal measure of length was based on "three barley corns, round and dry," though a standard more worthy of the name —the graduated yard length—was employed by the Royal Society in 1872.

Of recent years Sir Joseph Whitworth contributed greatly to the advance of standardization in engineering, which culminated in the formation of the Engineering Standards Committee in 1901; this committee had already done much useful work.

While standardization was of considerable assistance in simplifying engineering work, the danger of adherence to the standard after it was no longer up to date must be guarded against. It was therefore desirable that a committee to consider these matters should be composed of engineers, purchasers, and manufacturers, all actively interested in the subject with which they were dealing and working in co-operation, so that the necessity of revising existing standards would not readily arise.

Mr. Adams's remarks on the question of standards of light, dealt with a matter of direct interest to readers of this journal. He referred to the old British Parliamentary candle, the Pentane lamps subsequently invented by Mr. Vernon Harcourt, and the Carcel and Hefner lamps utilized in France and Germany respectively. A recent development of considerable interest had been the proposed Helium standard suggested by Mr. Nutting, of the Bureau of Standards this standard consisted essentially of a small capillary tube filled with Helium gas at a reduced pressure. It had been found that a steady light of one or two candle-power per inch of length, was obtained when the tube was subjected to an electrical discharge, and the colour of the light was good. The conditions were also said to be capable of easy reproduction but the life of the tube was at present short. (For a description of the Helium standard see *Illum. Eng.*, Lond., vol. i. 1909, p. 338). Mr. Adams professes to regard this standard as very promising. He also referred to the legislation affecting measurement of the illuminating value of gas, mentioning the recent decisions in London and Edinburgh to reduce the candle-power, and the tendency towards replacement of luminous by the calorific value.

We should have liked to have seen included in this Presidential address some reference to the recent international decision regarding the common unit of light, in Great Britain, France, and the United States, and also some mention of the desirability of a standard specification for metallic filament lamps—a question of very vital importance to the electrical industry just now. It was, however, gratifying to find that the subject of standards of light received so much consideration in a paper necessarily compressed in order to deal with the range of subjects included under the title of Standardization.

Errata.

October No. 1909, p. 649.

The second sentence, at the commencement of the Editorial should run as follows:—"In our present and last numbers will be found a list of the chief papers read on this occasion (pp. 648, 720)" .... &c.

The Third Annual Convention of the Illuminating Engineering Society.

HELD IN NEW YORK, SEPTEMBER 27th, 28th, AND 29th, 1909.

As announced in previous numbers of this Journal, the third annual Convention of the Illuminating Engineering Society of the United States took place on the above dates. We have also previously published a provisional list of the papers read on this occasion and this list, with a few modifications, we now repeat on this page. Several of the papers are reproduced in the current number, and we hope to deal with others in detail shortly. Meantime we give an abstract of some of the most important features connected therewith.

Presidential Address	W. H. Gartley
Report of Committee on Photometrical Nomenclature ...	Dr. A. C. Humphreys
Ethics of Illuminating Engineering	E. L. Elliott
Some Notes on Illuminating Engineering Practice in Europe...	H. Thurston Owens
The Importance of Illuminometry in Practical Illuminating Engineering	Norman McBeth
Efficiency of Lighting Installations	A. L. Eustice
Shades and Reflectors	Dr. Louis Bell
The Design of Reflectors, and the Standardization of Light-Distribution	A. J. Sweet
Diffusing Mediums	A. J. Marshall
Absorption and Diffusion of Various Forms of Glass Surfaces	Basset Jones, Jr.
Factory and Mill Lighting	L. B. Marks
The Photometric Laboratory of the United Gas Improvement Co.	C. O. Bond
The Mew Physical Laboratory of the National Electric Lamp Association	E. B. Hyde
Modern Photometric Practice in an Incandescent Electric Lamp Factory	Charles Deshler
The Problem of Heterochrome Photometry	P. S. Millar
Description of a Demonstration Lighting Installation ...	W. C. Morris
Discussion of the Efficiency of the Moore Light	Messrs. Hyde, Woodwell, Sharp and Millar
Auer von Welsbach	Prof. G. S. Barrows
Notes on Chemical Luminescence of Rare Earths	Angelo Simonini
The Light of the Firefly	Ives and Coblentz
Arc-lamps	W. D'A. Ryan
The Physiological Effects of Radiation	Dr. C. P. Steinmetz
Instruction in Illuminating Engineering at Cornell University	F. K. Richtmyer
The Allowable Frequency- and Voltage - Fluctuations in Incandescent Lamps	H. E. Ives

It is satisfactory to observe that the proceedings of the Society were on this occasion even more successful than in the past. Four hundred and fifty-four members registered as being present, and the Convention was of exceptional interest on account of its taking place simultaneously with the Hudson-Fulton Celebration in New York.

In addition to the technical papers read, we understand that a very enjoyable social programme was arranged and that members took the opportunities of inspecting the special public

illuminations in the city in honour of the occasion. There were also visits to the works of various important manufacturing firms in the locality.

Another novel feature in connection with this Convention was the exhibition of illuminating apparatus. This included a number of photometers of the Lummer Brodhun, Martens, Bunsen, flicker, and other types, and the display of lamps and lighting fixtures by the Welbach, General Electric, Holophane Glass, Westinghouse, and other companies.

The visitors were made welcome, on behalf of the City, by Mr. T. C. Martin, who was himself one of the charter members of the Illuminating Engineering Society. In his remarks Mr. Martin testified to the valuable work the Society is performing, and referred to New York as the city of light in the Western World, just as Paris was so regarded in Europe.

The **Presidential Address** of Mr. W. H. Gartley dealt mainly with the physiological aspects of illumination, and visual perception. He emphasized the need for researches on the hygienic aspect of lighting and the necessity of training physicists in the laboratory, in order to investigate the principles underlying good illumination. In this connection he laid special stress upon the fact that two of the papers dealt with laboratories recently established to deal epecially with gas and electric lighting, and special attention would be paid to physiological points. He also pointed out that $250,000,000 were spent each year in lighting; this served to indicate that, from a purely commercial standpoint, there was every reason to desire the study of the use of light to the best advantages.

Several reports of committees were presented. Dr. A. C. Humphrys presented that dealing with **Nomenclature and Photometrical Terms**. In doing so he referred to the pioneering work of Mons. Blondel on this subject, and to the recent decision regarding the Common International Unit of Light between Britain, France, and the United States. It was mentioned, however, that some objection to the term international unit had been raised in Germany on scientific grounds. It was felt that, in the absence of an international standard such an expression was somewhat unsatisfactory. Dr. A. H. Elliott, however, spoke of the value of series of standardised incandescent glow lamps as a means of preserving the national unit and described some experiences of his own with a set of lamps which he had carried with him to Germany and England, in order to compare their values in the different countries; the results were very satisfactory. The general feeling of those who spoke on this matter seems to have been in favour of the gradual adoption of the C.G.S. Units of length, &c. Dr. Rosa also referred to the International Photometrical Commission to meet at Zürich next year and pointed out that at present no official delegate from the United States had been appointed.

Mr. E. L. Elliott read a paper on the **Ethics of Illuminating Engineering** He drew attention to the misuse of the term "illuminating engineer," and pointed out the necessity for restraint in this respect; there were at present very few men qualified to describe themselves as such and the indiscriminate use of the term by unscrupulous persons was against the interests of illuminating engineering. Other discussions turned upon the desirability of those engaged in consulting work abstaining from connection with firms manufacturing illuminating apparatus. The system of charge for assistance rendered to consumer on the basis of the reduction effected in their lighting bills was spoken of with approval. Mention was also made of the part now played by supply companies in assisting the consumer with advice on the best use of their lights; some of those present, however, seem to think that there was a danger of companies encroaching on the work of private individuals in this respect.

Professor G. S. Barrows presented an address on **The Work of Dr. Auer von Welsbach**, who was referred to as the inventor both of the osmium electric glow lamp and the incandescent

mantle, and as one who had rendered great services in connection with gas and electric lighting. DR. A. H. ELLIOTT mentioned his work on the production of sparking alloys, *i.e.*, mixtures of metals which give a spark when rubbed and which are now being used for gas-lighting ignition.

MR. H. T. OWENS dealt with the Progress of **Illuminating Engineering in Europe**. He referred to the establishment of the Illuminating Engineering Society in this country, and also gave some account of street lighting methods in various Continental countries. He pointed out that there were still several illuminants in use in Europe which were at present but little known in the United States, notably the flame arc and high-pressure gas lighting. The study of these illuminants was, however, now being taken up in the United States with energy.

A paper presented by MR. F. K. RICHTMEYER on **Illuminating Engineering from the Educational Standpoint,** dwelt on the need for attention to this matter at leading technical colleges. This was also emphasised by the President, Mr. W. H. Gartley. In this paper reference was also made to the course instituted at Cornell University ; in addition the suggestion was made that it would be very desirable for a course of illuminating engineering to be organized for the benefit of architects.

Two very interesting papers were also presented by MR. C. R. BOND and DR. E. P. HYDE dealing with the **Photometrical Laboratories of the United Gas Improvement Co., and the National Electric Lamp Association respectively.** At the former laboratory arrangements have been made for life tests of all kinds of gas-lighting apparatus. Various kinds of gas at different pressures will be available for experiments. In addition use will be made of storage batteries feeding standardized electric glow lamps—an interesting illustration that the value of electric lamps in photometrical work is now being realized and taken advantage of by the gas industry. Dr. Hyde divided the proposed research work of his laboratory into two main sections, dealing with physiological and radiation phenomena respectively. He spoke of the importance of the *combined efforts* of physiologists and physicists in attacking these problems, and said that the laboratory had taken special methods to secure concerted action of this kind and to collect data of value bearing on the subject. In the discussion of these papers, Dr. Clayton Sharp remarked upon the growing tendency of commercial companies to encourage research on subjects which, though they had no immediate commercial application, had important consequences to the industry. Their policy in this matter was a far-sighted one.

Two papers were also presented by MR. SIMONI, and DR. COBLENTZ and MR. IVES respectively ; both of these dealt with radiation phenomena. Mr. Simoni dealt with **Chemical Luminescence of Rare Earths,** confessing himself an advocate of the theory of the behaviour of the incandescent mantle based on alternate oxidization and reduction. The second paper dealt with the **Light of the Firefly.** Some photographs of the spectrum of this light, which was continuous, were presented. It was estimated that the efficiency of firefly light was in the neighbourhood of 94·5 per cent, and the maximum luminosity was in the neighbourhood of 0·57 μ. The colour of the light, however, was greenish in character, owing to the restriction of the two ends of the spectrum. Theoretically, the authors suggest, an efficiency of 48 c.-p. per watt might be obtained from a monochromatic light, and 22 c.-p. per watt for a light which was fairly white in character. In commenting on the paper, Dr. Louis Bell pointed out the importance of studying radiation of this kind and analyzing the light of such phosphorescent sources of light ; this might lead us to devise a more efficient method of generating light in the future.

Another paper which dealt with raidation, chiefly from the physiological standpoint, however, was the address

of Dr. Steinmetz, who was inclined to think that ultra - violet light was often regarded as responsible for many bad effects of artificial illumination, which were really due to other causes. For instance, the concentrarion of radiation of any kind on the retina—what might be termed a "power-blow,"—was injurious. We must always remember the existence of a vast region of invisible radiation, including the infra-red, which predominated and was probably injurious. On the other hand, severe exposure to ultra-violet light was known to have a bad influence on the eyes, and it was possible that its evil effects were partly due to the formation of ozone and the breaking-up of the oxygen molecules in human tissue.

On the second day of the Conference a short address was also delivered by Mr. W. Clark president of the Frankin Institute and past president of the American Gas Institute who spoke in high terms of the work of the Illuminating Engineering Society.

Subsequently a paper was read by Mr. Ives on **The allowable frequency- and voltage-fluctuations in Incandescent Lamps.** In the discussion it was pointed out that in the case of high candle-power Tungsten units used for street lighting a much lower frequency of supply might be permissible—perhaps as low as 25. Dr. Sharp pointed out that the sensation of flicker was stronger when one looked at the illuminated object than when one looked at the source itself. However, the impression derived depended greatly on the surroundings. Dr. Hyde mentioned that very frequently multiple images of a moving object could be seen when the frequency of supply was sufficiently high to produce no visible flicker.

Dr. Louis Bell read a paper entitled **The Principles of Shades and Reflectors.** He distinguished between the double object of such fixtures of screening the eyes from direct rays, and also directing the light where it was wanted in an efficient manner. He also spoke of the tendency to etch the outside surfaces of prismatic glass. If this process is carried out unwisely, the whole intention of the prisms may be lost. Even the best silvered mirror did not possess a higher co-efficient than about 80 per cent, and soon deteriorated. On the other hand ordinary metal and enamel reflectors frequently possessed a co-efficient as low as 50 per cent. In reply to one query, which raised rather an interesting point, Dr. Louis Bell remarked that the absorption of a globe was practically independent of its diameter, provided the source was placed centrally.

Mr. A. J. Sweet presented a paper entitled **'Standardization of Conditions of Light Distribution.'** He divided ordinary problems of illumination into three main groups: (1) Illumination of room by a single central fixture. (2) Illumination of large interiors by uniformly distributed lights. (3) Illumination of long narrow rooms by a line of lights down the centre. In the discussion of this paper there seems to have been some difference of opinion expressed as to the desirability of such efforts towards standardization.

A paper was read by Mr. P. S. Millar entitled **'The Problem of Heterochromatic Photometry.'** After dwelling in general terms on the difficulty of comparing lights of different colours, Mr. Millar spoke of the desirability of using a standard of about the same colour as of a Tungsten lamp. He added, however, that these problems were too complicated for individual treatment, and concerted action was very desirable; he therefore moved a resolution that a committee should be appointed to consider the matter, and this resolution was formally taken.

A paper by Mr. Norman Macbeth entitled **'Some Results Obtained by Illuminometers,'** contained a comparison of theoretical and actual results in interiors having walls of different reflecting power, and illuminated by various groups of lamps.

Mr. L. B. Marks dealt with the subject of **'Factory Lighting.'** The author described the results of his inspection of the conditions of illumination in several factories, both day-

light and artificial. He pointed out that in many cases the general artificial illumination was but a fraction of that existing during the day-time. On the other hand the local illumination of tools was frequently needlessly high, with the result that the eye was apt to be distressed by the contrast between this and the surroundings. In addition, direct reflection from shining metallic parts was often very dazzling to the operator. He suggests that in many cases a slight re-arrangement might enable better conditions of ilumination to be obtained at a smaller cost.

A paper by Mr. A. E. Eustice dealt with the '**Operating Efficiency of Lighting Installations.**' The author mainly draws attention to the deterioration in the conditions owing to the dust, &c., which often render theoretical data quite incorrect. He mentions that reflecting glassware is usually less affected by the deposit of dirt than metallic reflecting apparatus.

Messrs. Hyde and Woodwell contribute a paper on the '**Tests of the Moore Tube Light Installation at a New York Post Office.**' The experiments included a study of the distribution of illumination in the room and of the specific consumption of the tube, which was found to yield about 9 M.S.C.P. per foot. The authors also describe some experiments on the effects of the periodic alterations in the light from the tube, and suggests that a two-phase installation is effective in reducing such alterations to a minimum.

Another paper by Dr. Clayton Sharp and Mr. P. S. Millar deals with the **Moore Tube Installation in the Engineering Societies' Buildings, New York.** In this case the tube was said to yield 8·1 candle-power per foot and 2·39 watts per mean horizontal candle-power. In the discussion of these papers several speakers mentioned that they have found more favourable figures. The power-factor of the tube was in this case stated to be 73 per cent.

Convention of Car-Lighting Engineers.

The Association of Car-lighting Engineers, the members of which are interested in problems connected with the illumination of railways and tramcars, held its annual Convention in Chicago on October 4th to 7th of this year. We note that among other problems discussed there were papers on 'The Application of Electricity to Railway Shops,' 'The Electrification of Steam Railways,' and 'Storage Batteries applied to Train-lighting.' In addition we note that an address was delivered by the President, and the various standing committees, including that on Standardization, reported progress.

Cantor Lectures on Illumination.

The series of Cantor Lectures entitled 'Modern Methods of Illumination,' delivered by Mr. Leon Gaster, editor of *The Illuminating Engineer*, London, before the Royal Society of Arts this year, are now being published in pamphlet form, and may be obtained at the cost of 2*s*. (two shillings) from the Royal Society of Arts, John Street, Adelphi, London. These lectures deal with recent advances in electric, gas, oil, acetylene, and other methods of lighting, and with modern developments in illuminating engineering.

Factory Lighting.

By L. B. Marks.

A paper presented at the Third Annual Convention of the Illuminating Engineering Society, New York, September 27, 28, 29, 1909; abbreviated.

This paper treats of the actual lighting conditions (both daylight and artificial light) found in a group of factories recently examined by the writer. The system of lighting employed, though far from ideal from the standpoint of the illuminating engineer, is extensively used in factory lighting practice. The factories examined comprise A, B, C, D, and E, the first four of which are devoted to the manufacture of type-writing machines and the fifth to the manufacture of ribbons, &c., for use in these machines. The aggregate number of employees in the five factories approximates 8,000. The total floor area lighted is about 13 acres. Electric current for lighting these factories is generated in each case at an isolated plant at the factory. The constant potential 220-volt system is used throughout, alternating current being generated and distributed at factories A, B, and E, and direct current at factories C and D. The connected lighting load of these factories aggregates 584·3 kw.

System of Illumination and Lighting Equipment.

With the exception of a few departments in factories D and E, the working spaces in all of the factories are lighted by localized lamps. These lamps are suspended from the ceiling by the usual flexible cords provided with ball adjusters for raising or lowering the lamps, or are hung from the ceiling by adjustable wooden arms, or are mounted on adjustable brackets on the walls, tables, benches, or machines. The lamps are backed by opaque (metal) reflectors usually 5 in. deep and 10 in. wide, enamelled or painted white on the inside.

In the daytime, when artificial light is not required, the bracket lamps at tables, benches, &c., are swung to one side and the drop lamps are raised to a position usually about 6 ft. above the floor.

When artificial light is required the drop lights are lowered by the operator to a position to suit his convenience, usually about 1 ft. to 2 ft. above the work, and the bracket lamps are swung directly over the work and either raised or lowered by the operator to suit his demands.

The almost universal practice is to provide one 16 candle-power lamp at each machine and for each bench hand. There are a few exception to this rule, notably in factory B, where two drop lamps are provided above the work of each operator in the aligning department.

The incandescent lamps used in the factories are the ordinary 220-volt lamps of the carbon filament type. A few enclosed arc lamps are used, chiefly in factory E, and a few mercury arcs in factory D.

With the exception of factory E, there is very little work in any of the factories that requires fine distinctions in colour. In some of the departments of this factory, on the other hand, a white light having approximately the same colour value as daylight is absolutely necessary to secure the best results in illumination.

Illumination Measurements.

Measurements of the illumination at the machines and other working spaces were made under actual operating conditions in the daytime and at night, the illumination measurements

for artificial light having been made in exactly the same location at machine, bench, &c., as the respective measurements made under daylight conditions ; a Sharp-Millar portable photometer, standardized at the Electrical Testing Laboratories, was used in making the tests.

In addition to measuring the intensity of illumination on the actual work in typical locations throughout the factories, the general illumination in the shops at night was also measured. This latter measurement was made in each case in a location as nearly as possible representative of the average illumination of the shop outside of the restricted field highly illuminated by the drop lamps. The location chosen for the measurement of general illumination was usually between two rows of drop lamps, on a horizontal plane from 3 ft. to 4 ft. above the floor. The measurement thus obtained therefore represents a fair average value of the general lighting at night of such parts of the machinery, &c., as are not directly underneath the drop lamps.

In the case of some of the measurements of illumination, the test plate of the photometer was placed in the same location as the operator's eye would be if he were viewing the work.

Readings of the photometer were in some cases made by the Manager and by the Superintendent of the factory, both under daylight and under artificial light conditions. These readings closely approximated to the measurements made by the writer and given in the accompanying tables.

Discussion of the Illumination Measurements, Factory A.

First Floor.

In the automatic screw machine department the amount of illumination at the machines was from four to seven times as great at night as in the daytime. The foreman of this department stated at the time the daylight measurements were made, that the illumination of the machines was then sufficient for the character of the work done in this department.

Though the illumination at night was greatly in excess of that in the daytime, it must not be inferred that it would be possible to successfully cut down the night illumination on the work to the same foot-candle value as the day illumination, without materially changing the manner in which the artificial illumination is applied. In the daytime all parts of the machine are about equally illuminated, whereas with the present system of localized light and reflectors the illumination of the machine at night is very uneven, one part being highly illuminated and another part, almost immediately adjacent, in comparative darkness.

The general illumination of the shop at night measured only $\frac{1}{4}$ of a foot-candle. This amount of illumination it about one-quarter of the amount required by the average person to read the print in an ordinary newspaper.

Second Floor.

Office.—The amount of illumination at night on the centre table in the office was sufficient to read fine print with ease. This illumination ($2\frac{1}{10}$ foot-candles) is considered a good reading light. In the daytime the amount of illumination in the same location was 40 foot-candles, or nearly twenty times that at night. The daylight illumination in this case is representative of good natural lighting for the purposes of a room such as this, although the amount of illumination might be considerably decreased or increased without discomfort to the eye. The lighting of the table referred to is accomplished by general illumination from a four-light ceiling cluster about 9 ft. above the floor.

Inspection Department.—The amount of illumination (20 5/10 foot-candles) on the inspector's table at night is very much more than would be required if the light were diffused instead of highly concentrated.

Third Floor.

The daylight illumination which the foreman states is sufficient for the work done at the drill presses in the machine-

room, is only 4·4 foot-candles. This measurement is very considerably less than the smallest value of the illumination by artificial light on any of the machines which are illuminated by drop lamps, and illustrates the point already discussed, viz., that only a comparatively low degree of intensity of illumination is required for good vision, if the illumination is well diffused.

FOURTH FLOOR.

Aligning Department.—On this floor the requirements of illumination are perhaps more exacting than in any other department in the factory. It will be noted that the illumination on the table in the daytime was 150 foot-candles. This value also represents the general daylight illumination in this department. In striking contrast with the amount of daylight illumination, it will be noted that the general illumination at night in the same location was only ¼ of a foot-candle, or 1/600 of that in the daytime. The night illumination on the typewriting machine on the table was 25·7 foot-candles. Attention is directed to the fact that in this installation the artificial light comes only from points directly above the machine, and that the shadows and direct (harmful) reflection resulting from this application of the light do not occur when diffused lighting is applied as in the daytime. In daylight the under side of the machine and the interior parts are moderately well lighted, and there is comparatively little glare from light reflected from the polished parts of the machine. At night, on the other hand, when the artificial light is used, the illumination of the under side of the interior parts of the machine is very low in value, and because of the sharp shadows and strong glare produced by the concentrated light, the operator finds considerable difficulty in seeing the fine details of the work. Moreover, he is subjected to severe eye strain, as the result of which his ability to see well decreases rapidly with the amount of time during which he is continuously at work.

With a highly concentrated light on the work and a dark field just outside of the work, the conditions are such as to invariably result in eye-strain. The operator finds that after working under such conditions for a period of time he requires a stronger light on the work to see the details as well as he could when he began the work. By virtue of the decrease in visual acuity resulting from the subjection of the eye to this character of illumination, the operator is unable to perform his work with either the accuracy or the celerity possible in daytime.

Type Bar Department.—The foreman of this department stated that the daylight illumination (8·2 foot-candles) was sufficient for the particular work in hand. The value of the daylight illumination given in the table represents practically the general illumination of this part of the room in daytime. The general illumination at night is approximately ¼ of a foot-candle or about 1/32 of the amount in daytime. The localized artificial illumination on the machine was 6 1/10 foot-candles. The lamp reflectors in this case were in the position of normal operation, about 2 ft. 6 in. above the machines.

SOUTH BUILDING.

Japan Department.—The measurements of illumination made in the striping room show clearly the strong contrast in illumination of contiguous parts of the striper's bench. Within a working space of 7 ft. on this bench there was a variation of about 3,600 per cent in the amount of illumination. One of the objections to the present method of the illumination of this department at night is that the eye of the operator is subjected to violent shocks in glancing periodically from an intensely illuminated zone to one of almost absolute darkness. Another objection is that the quality of the artificial illumination renders it difficult for the operator to distinguish a blue colour on a black background. As most of the striping is executed in blue lines on a black background the importance of having an artificial light of a quality that will strongly bring out the blue colour on the dark background is manifest. A well-

diffused light, with a strong preponderance of short rays (blue and green) is best adapted to meet the requirements of this work.

Discussion of the Illumination Measurements, Factory B.

First Floor.

Press Department. — The daylight illumination on the punch press near the window in this department was 35 foot-candles, and the illumination at this press at night 37 foot-candles. This amount of artificial illumination is probably ten times as much as would be necessary if the lighting were diffused, instead of strongly concentrated in a very limited zone close to the work. The measurements show that at night with all the lights in operation the general illumination on a horizontal plane 3 ft. 6 in. above the floor was only 3/100 of a foot-candle, or less than 1/1,000 of the localized illumination.

One of the objections to the use of local lamps very close to the work is the resultant direct reflection (glare) from the work. In the punch press department this objection is not so serious as in departments in which machines and work with highly reflecting surfaces are illuminated. But even in the punch press department, where the surfaces are dull, the measurement shows that the amount of direct reflection from the machine to the eye of the operator was 1·31 foot-candles.

On the punch press near the centre aisle there is not sufficient daylight illumination for the operator to do his work, and the natural light in this location must be supplemented by artificial light. Two drop lights are used at the press, one of these being in front, 1 ft. above the work, and the other in the rear close to the platen. The illumination at the press on the side facing the window, on a bright day, with both of the lamps lighted, was 13·4 foot-candles. On the opposite side of the press when the lamps were extinguished, the illumination was only about one-fifth of a foot-candle. The lamps and reflectors at this press had deteriorated.

The daylight illumination near the centre of this room was extremely low in intensity. There would be considerable advantage in substituting for the clear glass in the windows in this department prismatic glass designed to throw the maximum light on the punch presses near the centre aisle.

Second Floor.

Milling and Profiling Department.—The measurement of the daylight illumination (2·2 foot-candles) at the machine near the centre aisle shows that artificial light is needed to supplement natural light in this part of the shop. There is no doubt that the introduction of suitable prismatic glass in the windows on this floor would result in the substantial reinforcement of the daylight at the machines in the darker portions of the floor.

At the vertical milling machine the daylight illumination (4·4 foot-candles) was sufficient for the work. At the same machine at night the illumination measured 42·5 foot-candles, or nearly ten times the amount which the foreman stated was sufficient for the work during daylight. Here again we have an example of the great intensity of light apparently needed at night to adequately illuminate the work with the localized system of lighting in use at this factory.

Third Floor.

Drill Press Department.—At tapping machine No. 383 in the centre aisle the amount of illumination at night was nearly eight times as much as the foreman of this department stated was sufficient for the work during daylight. The daylight illumination (2·5 foot-candles) at this machine, although sufficient for this work on a bright day, is very small in amount, and should be reinforced by installing suitable prismatic glass in the upper windows on the north side of the room. If the only consideration were to increase the amount of daylight in the interior of the room, the installation of prismatic glassware in the lower windows as well as in the upper would be highly desirable. The introduction of this

glass in the lower windows would, however, be objectionable, because the bench hands and some of the machine hands would be compelled to face a lighting surface of comparatively high intrinsic brightness.

The direct reflection of light from the horizontal surface of the oil in the type bar drilling machines in this department was measured, first, when the operator was at work in a standing position, and second, when the operator was at work seated at the machine. In each case the test plate of the photometer was placed in the position that the eye of the operator was in when he was at work. The direct reflection from the oil to the eye of the operator was 1·05 foot-candles at one machine and 1·0 foot-candle at the other machine in the tests in which the operator was standing, and 0·4 foot-candle when the operator was seated. There is no doubt that the direct reflection in the first two instances materially reduces the visual acuity, especially as the bright image of the lamp is constantly seen in the oil by the operator while he is at work.

FOURTH FLOOR.

Tool Room.—The general illumination of this room at night was less than one-fifth of a foot-candle, with all the lights in operation.

The daylight illumination in the centre of the room was 9·9 foot-candles, which is sufficient for the class of work done.

In the platen roll department the daylight illumination on machine No. 431, located 5 ft. from an unshaded window, was 250 foot-candles. This measurement was made at 4.20 in the afternoon of a clear day. The shades at the windows should be drawn to reduce the intensity of daylight illumination on the work when the amount of light reaches these high foot-candle values.

FIFTH FLOOR.

Type Bar Adjusting Department.—The amount of illumination at night on one of the tables was 50 foot-candles, whereas at this table the daylight illumination, which was entirely adequate, was only 18 foot-candles. On another table, the night illumination was 38 foot-candles, and the day illumination 90 foot-candles. This intensity of diffused daylight illumination is not sufficient *per se* to cause eye-strain if the operator is not continuously facing the window through which the light enters. With localized artificial lighting, however, such an intensity may cause considerable eye-strain. In fact 1/10 or even 1/20 of this amount of illumination might easily be excessive if the light is not suitably diffused.

SIXTH FLOOR.

Final Inspection Department.—The intensity of illumination on the work was 45 foot-candles. The disadvantages of localized illumination of this intensity have already been commenced upon.

SEVENTH FLOOR.

Aligning Department.—In the aligning department two drop lights are used above the work of each aligner. The foreman of this department stated that originally only one lamp was used for each aligner; but that the operators complained of insufficient illumination. The lamps are placed very close to the work. On account of the high polish of the work, the direct reflection (glare) is very great.

The general illumination on this floor was extremely low, being of the order of that on the other floors.

Discussion of the Illumination Measurements, Factory C.

FIRST FLOOR.

Punch Press Department.—The amount of illumination (3·2 foot-candles) at the punch press at 5.30 in the afternoon of a cloudy day was measured on the side of the press nearest the window. The daylight in this location must be supplemented by artificial light in order to adequately illuminate the work. In daylight there is practically no glare from the press or work, the diffuse reflection amounting to 4/10 of a foot-candle.

Second Floor.

Office.—The minimum amount of illumination (2·6 foot-candles) on the centre table at night was sufficient for reading fine print with ease. This illumination is practically the average general illumination in the working part of the room. In this connexion it may be stated that an operator whose work really demanded no more light than this, would not find this intensity of illumination sufficient if he came into the room after having worked on a machine which was illuminated by a localized drop lamp of the type used in the factory. The subjection of his eyes to the highly concentrated light of the local lamp stops down the pupil of the eye to such a degree that an intensity of artificial illumination of 2 foot-candles, which might otherwise be sufficient, would now be entirely inadequate.

Straightening Department.—The intensity of the illumination at night is approximately the same as that which is sufficient for this work on a bright day at 5.45 in the afternoon. The incandescent lamps are placed close to the screen, and produce an uneven illumination which is objectionable. The use of lamps with linear filaments in place of the ordinary incandescent lamps would result in almost absolutely uniform illumination on the working portion of the screen and would overcome the objection referred to.

Third Floor.

Tool Room.—At the milling machine 8 foot-candles of natural illumination were sufficient for very exacting work in the daytime, whereas 76 foot-candles of electric light were used at night. There is no doubt that with well-diffused and directed artificial light, the intensity of the illumination on the work at night might easily be reduced to one-tenth of the present amount with beneficial results from the standpoint of vision.

The general illumination of this part of the room in the late afternoon was 8 foot-candles (minimum). At night the general illumination in the same location was only 14/100 of a foot-candle. In other words, the general lighting of the machine at night was less than 1/50 of that in the daytime and the local lighting of the machine at night was almost 10 times that in the daytime.

Striping Room.—The illumination on the striper's table at night is greater than that in the afternoon of a bright day. The ability of the stripers to see the work would undoubtedly be enhanced if the intensity of artificial illumination were decreased and the light better diffused.

Varnishing Room.—In the varnishing room the illumination on the work at night directly under the drop light is greater than the daylight illumination in the same locality. The usual position of the drop light is about 1 ft. above the work. Sometimes, however, the operator pulls the lamp down to within 6 in. of the work, in which case the illumination is 150 foot-candles, an intensity that is absolutely prohibitive with localized illumination. This latter value is over four times the intensity of the daylight illumination which was adequate for the same work.

Drafting Room.—The intensity of illumination on the drafting-boards at night is more than ample for the requirements of the most exacting work.

Fourth Floor.

Aligning Department.—The practice is to provide each of the aligners' tables with one 16 c.-p. lamp. On the table on which the measurement of illumination was made, the reading of the photometer showed 250 foot-candles. It is safe to say that the illumination on the work at night under these conditions is at least 25 times the amount that would be required for work of this character in well-diffused artificial illumination. The evil effects of highly concentrating the light upon the machine in this way are strikingly shown in the measurement of direct reflected light from the surface of the machine. The measurement of direct reflected light (glare) from the typewriting machine in this case showed that the intensity of the

glare was considerably greater than the intensity of diffused illumination that would be required to adequately illuminate the machine. In other words, about 9/10 of the light applied to this machine was not only wasted, but the light was applied in such a way as to prevent good vision.

The general illumination of the aligning department at night was only ¼ of a foot-candle, or 1/260 of that in the daytime.

Top Plate and Carriage Assembly Department.—It will be noted that the night illumination on the assembling table was about three times the daylight illumination on this table; the daylight illumination at the time the measurement was made was considered ample for the work.

Inspection Department.—The illumination on the inspectors' table at night was 55 foot-candles on the work directly under the table lamp. This intensity is from five to ten times as much as would be required for this work with well diffused illumination.

Base Assembly Department. — The illumination on the work at night is over double that in the daytime.

(*To be continued.*)

The Physical Laboratory of the National Electric Lamp Association.

By Edward P. Hyde, Director.

A paper presented at the Third Annual Convention of the Illuminating Engineering Society, New York, Sept. 27, 28, 29, 1909.

The inception and development of the science and art of Illuminating Engineering constitute an epoch in the progress of civilization. Its principles rest on the correlation, after a new scheme, of the scattered phenomena of the ancient sciences of physics, physiology, and psychology and the dictates of the ancient art of architecture. Its accomplishments depend on the application of its principles to the solution of practical problems of lighting. One of its most attractive and yet most perplexing features is its very complexity. The phenomena and laws of the sciences of physics, physiology and psychology are well established; the dicta of the art of architecture are well formulated; the correlation of these laws and dicta as a basis of practical application to lighting is a distinct achievement of the new art and science from which this Society has taken its name.

The future of this new science, and therefore the success of this new Society, will depend upon the establishment of sound basic principles. Hence it is of paramount importance that we give our constant attention to the development of the principles of the science, lest its vitality should be sapped by injudicious application of unwarranted assumptions.

It is therefore peculiarly appropriate that I should undertake, even at this time, when the laboratory is still in many respects more anticipated than real, to describe before the Illuminating Engineering Society the purposes and objects of the new Physical Laboratory of the National Electric Lamp Association.

Its purposes and objects are so intimately associated with the development of the basic scientific principles of Illuminating Engineering that it may well have been called the Illuminating Engineering Research Laboratory. In order, however, to emphasize its purpose of developing the pure science rather than the applied art of illuminating engineering, and to distinguish it from the many other research laboratories which have for their object the technical development and improve-

ment of some commercial commodity, it has been called simply the physical laboratory. But although for simplicity it has been given this name, its functions extend beyond the confines of physics, and, as we shall see later, some of the most important problems to be investigated lie in the domain of physiology and physiological optics.

The physical laboratory had its inception in the spring of 1908, when an invitation from the Advisory Board of the National Electric Lamp Association to organize a laboratory for the study of the sciences on which lighting depends, was accepted by the author. In the fall of the same year the duties of the office were entered upon, and plans were initiated for the organization of the work.

Although the selection and equipment of a suitable building were matters of immediate importance, it was felt that to a much greater extent the success of the laboratory would depend upon the personnel and the wise choice of the broad lines of activity to be pursued. It is the purpose of the present paper to outline briefly the organization of the work as far as it has been established, rather than to present photographs of buildings and equipment.

The fundamental idea which has prevailed in the organization of the work is the proper co-ordination of physics and physiology, the proper co-operation of the physicist, the physiologist, and perhaps the psychologist. The work of Helmholtz attests to the accomplishments of a proper co-ordination of physics and physiology. Unfortunately there was but one Helmholtz. Moreover the domains of the widely extended sciences of physics and physiology are ever widening, and the possibility of the happy combination of the physicist and physiologist in one man is ever diminishing. This differentiation of science must be accompanied by a co-operation of the scientists if the great middle fields of science are to be adequately covered.

The organnization of the laboratory is proceedings with this idea as the foundation. The development contemplates no sharp distinctions among the different divisions of the work. The problems to be investigated, however, group themselves roughly into three classes ; and therefore require, in order to ensure the proper attention to each, a threefold division in the organization. The three groups of problems to be investigated may be classified as : (1) those that have to do with the production of luminous energy; (2) those that have to do with the utilization of luminous energy ; and (3) those that have to do with the effects of luminous and attendant radiation.

Under the first class will come the investigation of the laws of radiation and of the radiating properties of matter. The problems in this class are purely physical, and the corresponding division will be entrusted to a competent physicist. Although much progress has been made in the study of the laws and phenomena of readiation, our knowledge in this field is still very meagre. Certain simple laws for the ideal *complete radiator* have been deduced as a result of theoretical and experimental investigation, but the values of the constants appearing in the corresponding equations are in many cases still in doubt, and even the form of the expression is not always agreed upon. Our knowledge of the deviation from the laws of the *black body* in the radiation of material substances is of most limited extent. The classification of matter on the basis of its radiating properties, and the correlation of these properties with the other characteristic properties of matter have scarcely been attempted. Such a classification would be of the greatest scientific interest, and of invaluable benefit in the further development of the art of lighting.

Under the third class will come the investigation of the effects of light and the attendant radiations on the eye, on the skin, and on microscopic organisms. The problems in this class are physiological, and the corresponding division is under the charge of a trained experimental physiologist. The possibilities in this field of work are un-

limited, but the obstacles in the way of conclusive results, particularly on the effect of light on the eye, are unusually great, owing partly to the inherent difficulties in the experiments, and partly to the psychological element which enters to complicate the observations. The importance of the work is rapidly being recognized the world over as vital to the welfare of the race. In Germany the question of the effect of ultra-violet light on the eye is occupying the attention of ophthalmologists, physicists, and engineers. In England a commission has recently been appointed to investigate the cause of cataract in the eyes of workers in certain kinds of glass. It has been suggested that the malady may be due to the injurious effect of certain radiation from the molten glass. In this country, largely through the efforts of the Illuminating Engineering Society, the question of the effect of light on the eye has been kept constantly before the attention of the public. In order that the work in our laboratory may most surely and quickly lead to results the co-operation of practising ophthalmologists is essential.

Intermediate between these two classes of problems (the first and the third) which are distinctly different, there is another (the second) which forms the connecting link. Touching on one side the physical production of light, and on the other the physiological effects of light, this intermediate division of the work will embrace most of the scientific problems peculiar to illuminating engineering. Investigations on the absorbing, reflecting, and diffusing properties of matter, the measurement of light, *i.e.*, photometry, and the study of the complex pheonomena of colour and colour sensation, properly come within the scope of this department of the work.

As stated in a previous paragraph, the organization of the work into these three divisions does not contemplate the establishment of sharp lines of demarcation between them. It is intended rather to ensure attention to all phases of the problem before us, in order that the concomitant development of the different phases may conduce to the most valuable integral result.

There are two necessary adjuncts to successful research—a library and an instrument shop. To properly correlate the known facts of science is frequently as valuable as original results; and there is no better way to acquire suggestive ideas and inspiriting stimulus to further research than to read the literature of the accomplishments of others. The Physical Laboratory is fortunate in having the opportunity to develope a good working library which will be supplemented by the various scientific and technical libraries already established in Cleveland, and available to members of our laboratory. A general library for all branches of the National Electric Lamp Association is being organized under our immediate direction, and in addition to a number of scientific books and bound periodicals which have been purchased, the library is already receiving regularly sixty scientific and technical journals, together with a number of others of more commercial or popular interest. The library is at present located in the Physical Laboratory building and is therefore most convenient for reference.

The other adjunct, the instrument shop, has likewise received considerable attention. In fact, this department has been given perhaps the most attention up to the present, and consequently is most completely organized. The equipment consists of an 8-inch Rivett back-geared precision lathe, a 14-inch Hendey-Norton engine lathe, a No. 1½ Brown & Sharpe universal milling machine, a 21-inch Barnes drill press, a Willey high-speed sensitive friction drill-press, and a Willey bench grinder, together with a wood-working bench and necessary accessory tools. All the machines have separate electric drive, with direct connexion wherever possible. A well--trained mechanician is already producing specially designed apparatus for the laboratory.

The present personnel of the laboratory, in addition to the Director, is as follows:—

Mr. F. E. Cady, B.S., Massachusetts Institute of Technology, 1901; Scien-

tific Assistant to the Director. Mr. Cady was formerly Assisant Physicist in the Bureau of Standards, Washington.

Dr. Herbert E. Ives, B.S., University of Pennsylvania, 1905; Ph.D., Johns Hopkins University, 1908; Physicist in charge of Division II. of the work as outlined above. Dr. Ives was formerly Assistant Physicist in the Bureau of Standards, Washington.

Dr. Percy W, Cobb, B.S., Case School of Applied Science, 1894; M.D., Western Reserve University, 1902; Physiologist in charge of Division III. of the work. Dr. Cobb was formerly assistant in the Physiological Rseearch Laboratory and lecturer on the special senses at the Western Reserve University.

Mr. Wm. Würth, Mechanician. Mr. Würth has obtained his training in the instrument shops of the Société Genevoise, Geneva, Switzerland, and of the Adam Hilger Co., London.

One stenographer and a laboratory boy.

It is the intention to secure another physicist to assume charge of Division I., and in addition several assistants, as soon as the devolopment of the work justifies it.

In conclusion, it may be well to say a few words regarding the laboratory building and equipment. The Laboratory at present is established in a small one-story and basement brick building recently occupied by the Buckeye Electric Co., but originally built by Mr. Charles F. Brush. The walls of the building, which are double, with an air space between, are quite thick, being thus well-suited for laboratory purposes. The building stands alone, open on all sides. It is supplied with hot and cold water, natural gas, and direct and alternating current power. In addition a 132-cell, 120-ampere-hour storage battery of the Willard type has been installed in a separate building for the exclusive use of the laboratory.

The laboratory equipment is still very meagre, owing to the difficulty of securing scientific instruments at short notice. Some apparatus has already been obtained from instrument makers in the United States, and numerous orders have been placed with foreign manufacturers. A special trip abroad was made recently by the writer for this purpose, in order that advantage might be taken of any recent foreign developments. Much of the foreign apparatus has already been shipped, and we hope at some later date after this apparatus has been received and installed to present before this Society a more detailed statement regarding the equipment and work of the Laboratory.

The Purification of Roumanian and other kinds of Petroleum for Illuminating Purposes.

We notice in the *Bursa* (Bucharest) for October 3rd, a reference to an important research carried out by Dr. Edeleanu on the qualities of Roumanian petroleum for burning in oil-lamps. It is pointed out that considerable difficulties have been experienced in preparing the Roumanian oil in a condition such that it answers as well for this purpose as the American and Russian varieties.

The Roumanian oil has two drawbacks. There is a tendency for it to smoke when used in oil-lamps; also when the flame is turned up past a certain point, it is apt to produce a very disagreeable odour. Dr. Edeleanu, however, finds that this is due the presence of a certain proportion or aromatic "closed-chain" unsaturated hydrocarbons which are not removed by the ordinary processes of purification. By treatment with sulphur dioxide this objectionable ingredient can be removed and the oil is then fit to be used for the same purposes as that found in the United States, Russia, and other countries.

This process, it is suggested, will also be of value in connection with the purification of certain varieties of petroleum of similar constitution such as occur in Galicia, and some parts of Russia, North America, and the Dutch Indies.

The Psychology of Shop Lighting.

A POINT of some interest in connexion with shop lighting is raised in the most recently published section of the Cantor Lectures on illumination, recently delivered by the Editor of this journal before the Royal Society of Arts (*Journal of the Royal Society of Arts*, Sept. 10th, 1909).

It is pointed out that a change in the motives of window display seems to have been making itself felt of late. In many shops the window display is regarded mainly as an inventory, as complete as possible, of the goods kept in stock. The customer is expected to make up his mind what he wants by inspection of the window, enter, and ask for this article. This naturally involves crowding the windows, and makes effective lighting methods difficult to achieve.

Now, however, perhaps especially in the United States, it is becoming felt that a tasteful shop window would be mainly devoted to novel and specially interesting goods, so that the passer-by may come to regard its contents, not as a catalogue, but as a summary of the most recent developments; this leads him to look to the window for novelties, and not to pass it by, assuming, by the force of habit, that it contains nothing new. He would, therefore, no longer be expected to make up his mind as to his requirements before entering, but would be induced to enter whilst yet undecided as to whether he meant to purchase, and would be prepared to entertain suggestions and assistance from the shopman. It is possible that this newer attitude towards window-dressing may have a beneficial influence on the lighting of such windows in the future.

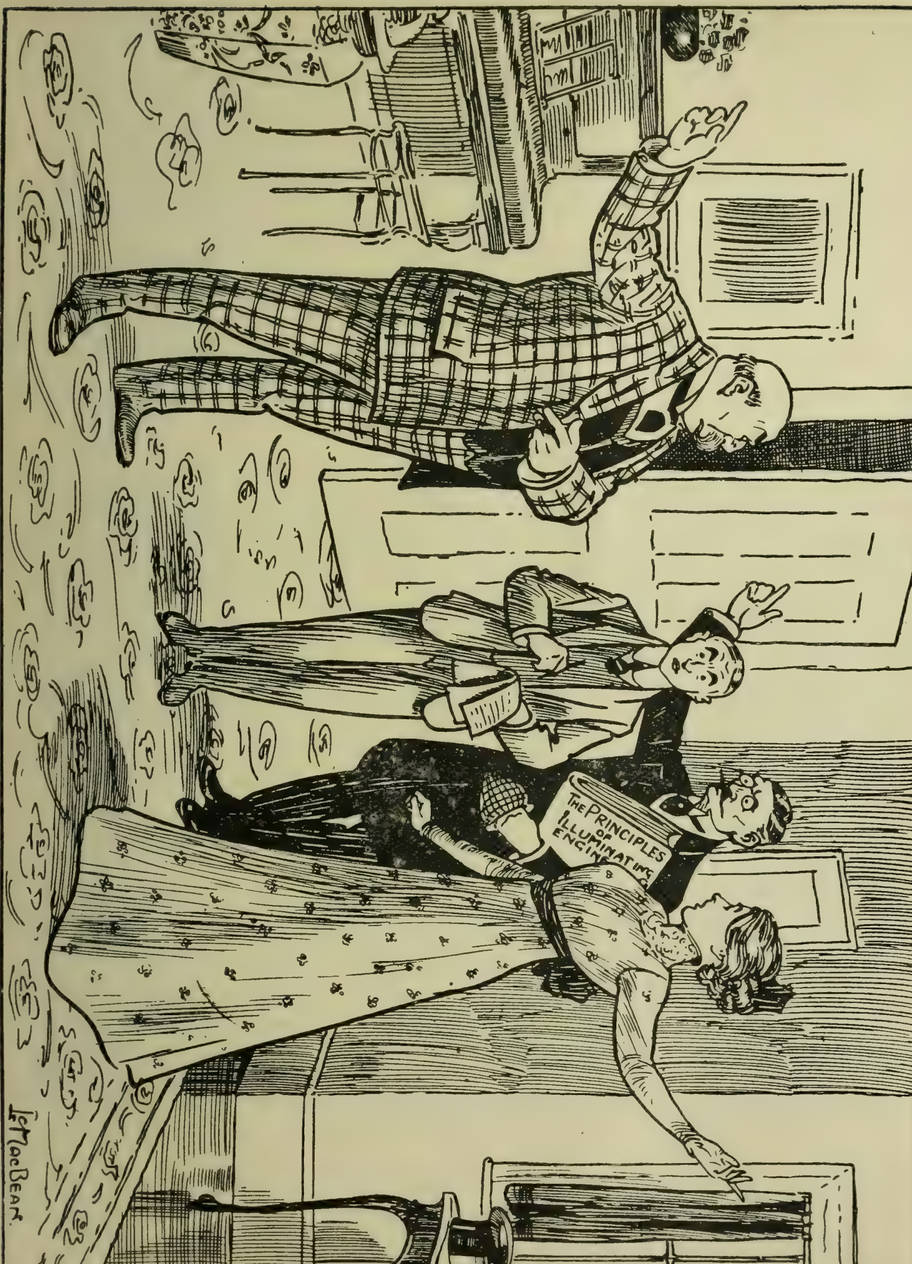
Popular Interest in Illuminating Engineering.

THE amusing cartoon which, by the courtesy of the Editor of *Electrical Industries and Investments*, we reproduce on the opposite page is a striking testimony to the recognition of the fact that the general public are coming to take a keen interest in matters of illumination. This is a fact which has often been pointed out in these columns; it has, perhaps, been realized even more fully in the United States, where educational lectures for the benefit of the general public have been organized for a considerable time.

Any one examining this illustration will sympathize with the contractor in attempting to satisfy the apparently conflicting views of his clients. No little tact is often required in order to meet these views, and yet to avoid eccentricities in lighting which are not for the ultimate welfare of the consumer.

At the same time it should be appreciated that the keenness of the public in this matter helps, in the long run, to stimulate progress in illumination, and acts as an assistance to those engaged in the business of supplying light and lighting fixtures. Appreciation of knowledge of illuminating engineering on the part of a consumer should be welcomed by the contractor. All that is necessary is for him to study the subject for himself, and he is, no doubt, becoming fully aware of the importance of keeping well informed on the most recent developments. By so doing he will be able to afford the consumer genuine help, and will have at his disposal data by which he can substantiate his suggestions in the case of a difference of opinion.

We are not quite clear as to the identity of the imposing individual in the centre, who carries the bulky volume entitled 'The Principles of Illuminating Engineering.' We assume, however, from the fact that his attitude suggests a compromise between the opposing views on his right and left, that he is the expert illuminating engineer coming to the assistance of the consumer and the rescue of the contractor.



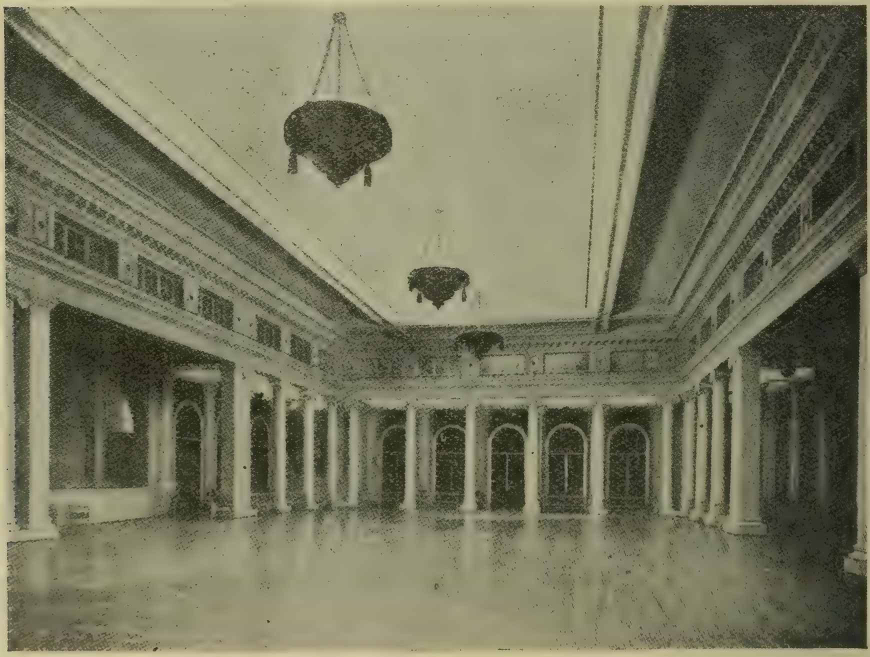
The Troubles of the Electrical Contractor.

No. V. He receives instructions and technical advice as to the positions of the fittings.

(*Elec. Industries*, September 22, 1909.)

A Ball-Room Lighted by Inverted Tungsten Fixtures.

Several illustrations have been given in this journal from time to time of the application of inverted lighting with tungsten fixtures to interiors. A new field for this system has been opened out by the coming of the high candle-power Tungsten lamp. The accompanying illustration, from a recent number of *Popular Electricity*, of a



ball-room in Chicago lighted by this system may, therefore, be of interest. In a ball-room it is, of course, essential to adopt a soft, pleasing system of illumination without any trace of glare. At the same time, the architectural features of the room must often be borne in mind, and it would probably be considered undesirable to adopt a system of lighting which might lead to "flatness," and a total absence of shadow.

The problem is, however, somewhat simplified by the fact that in a ball-room there is necessarily a large open central area over which a uniform diffused illumination is needed; for this purpose the inverted system is probably well adapted. On the other hand, the system of lighting should presumably be such as to show up in relief recesses and columns surrounding the central space. Probably æsthetic considerations would demand the production of fairly soft shadows, and, if we may judge from this illustration, this has not been lost sight of.

Light Conversations on Illuminating Engineering.

By Athos.

1. *On Glare.*

"Whenever I read anything about illuminating engineering," said the Electrical Engineer fractiously, "I find that they advise me 'to avoid glare,' 'to keep bright sources out of the field of view,' &c. It makes me tired. Platitudes! Any one but a fool *knows* that bright lights ought not to be placed in the direct range of view nowadays!"

"They do it though," said the Man of Sense, thoughtfully.

"What I chiefly object to," went on the Electrical Engineer solemnly, "is the constant statements of unscrupulous people about electric light being bad for the eyes." Here he glanced severely at the Gas Engineer, who had been chuckling over the electrical papers in a corner, but now looked up, all attention.

"A medical authority has said that electric light has done a large amount of serious harm to the eyes. If you desire to preserve your eyesight and that of your children, use gas!" he quoted gleefully.

"Talking about fools," he continued, glancing casually at the Electrical Engineer, "have you ever noticed how few shops in, say, Holborn or the Strand are even moderately well lighted by electricity? Almost every day I pass a bookseller in Chancery Lane who judiciously illuminates his window with naked glow-lamps, wedged between the glass and the titles of his most recent publications, and I could quote dozens of similar cases. We ought, perhaps, to be thankful that he does not give us a row of flame arcs in addition! Oh, yes, believe me, the advice is needed—for electricians!"

"The other night," said the Electrical Engineer heatedly, "I happened to stroll down Fleet Street. "It has always struck me as being in every sense a 'glaring' exhibition of bad light-distribution. The lights are, bearing in mind their concentrated brilliancy, far too low. They are extremely dazzling to both drivers and pedestrians, and far more so than any flame arc is likely to be. Incidentally, I may add that they have the effect of 'killing' the illuminated signs and show-windows lining the street in their vicinity. I now notice that the gas people have gone one better by installing a most powerful light near the end of Chancery Lane. Personally, I was blind for several seconds after passing it. Most flame arc-lamps are at least designed to throw the light downwards, and the pedestrian has to stare almost vertically upwards in order to get really dazzled. But the concentrated brilliancy of the naked high-pressure mantle cannot be avoided; and for some reason no effort is ever made to soften or diffuse the light by suitable shades and globes, though it is at least attempted with all electric arc-lamps!"

"There is a proverb about people in glass houses," remarked the Man of Sense casually.

The Gas Engineer prepared to collect himself; he was in reality a little staggered. Before hostilities could recommence, however, *Lumina* broke in: "The truth is that neither the Gas nor the Electrical Engineer is quite a free agent. Public taste in all these matters still demands education. Educated people, no doubt, are already becoming impressed with the folly of naked lights in positions likely to cause glare, and it is this class that is mainly liable to be influenced by statements to the effect that this or that illuminant is bad for the eyes.

But to the masses the new intensely bright illuminants now available are still new toys; they have to learn to use them wisely and the Illuminating Engineering Society will help to stamp the lesson home. Meantime, however, there are many people whose only idea of judging the effectiveness of illumination is to look straight at the source, instead of the area or the object it is intended to illuminate. Unless the actual light appears of great intrinsic brightness they feel they are being done out of their money. Naturally such a judgment puts a premium on glare."

"What about the City Corporation?" put in the Electrical Engineer.

"Peoples' minds," said the Man of Sense sententiously, "seem to be in a state of transition. The desire for dazzle is, I believe, passing away. I know a restaurant not 100 miles from us. At one time they used naked filaments in abundance, and seared our eyes. Then one day some perverted principle of illuminating engineering entered into the mind of the manageress, and we descended into subterranean gloom to find that all the lamps had been thickly swathed in folds of what the Americans call 'fool crinkled paper.' The light was certainly soft—what there was of it. Unfortunately several customers fell down the stairs, which were far from soft. The ultimate result was that the crinkled paper was removed, and the manageress took unto herself seven devils, that is she installed brighter lights than ever."

"That must have been an electrically lighted restaurant," said the Gas Engineer.

"What you describe," said the Philosopher, "is a common and excellent example of a well-known mental oscillatory phenomenon."

The Acetylene Man had just entered the room, and immediately plunged into the conversation.

"Acetylene is the best of all illuminants from the hygienic standpoint," he explained tersely. "There is no glare, as in gas and electric light. Soft and beautiful, it approaches more nearly to natural sunlight than any other illuminant—"

Both the Gas and Electrical Engineer turned to rend him.

"The Tungsten lamp—"

"The modern incandescent mantle—"

But the Acetylene Man waved aside interruption. "The colours of objects illuminated by acetylene appear true. Its richness in ultra-violet light—"

"I think you mean violet light, don't you?" said *Lumina*, mildly.

"All the same," said the Acetylene Man breezily.

"But how do you know?" asked the Man of Sense curiously. "Don't you have to test these things with photometers or radiometers or calorimeters, or something of the kind?"

"Oh, I leave all that to the scientists and the professors," said the Acetylene Man pityingly. "The verdict of the general public is enough for me. The acetylene business is extending, still extending! That shows that the common sense man in the street confirms my views."

"Well," said the Man of Sense dubiously, "I only ask because I met the Petrol-Air Man yesterday, and he assured me that his light was better than all others because it contained *less* ultra-violet rays. I wondered how *he* knew too. I suppose it was because he was selling plenty of petrol-air gas plants!"

"They both talk bunkum," said the Gas Engineer rudely. "All modern illuminants are extending, especially gas. But this doesn't tell you whether they contain ultra-violet light or no. As a matter of fact no one cares."

"Electric lighting is extending all right too, thanks," said the Electrical Engineer. "At the same time I don't like all this talk about ultra-violet light and intrinsic brilliancy and so on. It's bad for business."

"Unfortunately, or perhaps I should say fortunately," said *Lumina*, "it's

too late to take that view. You have already given expression to your resentment against people who say that electric light is bad for the eyes. It often is. So is gas lighting, and acetylene lighting, and petrol-air gas lighting, and all other illuminants. But they *need not be* if used properly. Your right course is to show people how to use them in a sensible way. I may add that these physiological questions have now been raised, and it 's too late to try to ignore them; I notice, for instance, that *The Lancet* has been taking up the matter lately, and you may be sure the Illuminating Engineering Society will do so. If you believe in your own illuminant you ought to desire to have these things cleared up. As long as they are allowed to remain in a state of vagueness there will always remain a chance of working on popular prejudice."

"I am not surprised that our friend here doesn't like talk about glare," said the Gas Engineer, "The ease with which electric lights can be placed in any position is responsible for their being often placed in the direct range of sight. The general public have got so used to seeing naked filaments thus placed that they now connect this state of things permanently with electric light. And just look at the posters! I saw one the other day in which a ring of people round the supper-table are gazing fixedly at a metallic filament naked lamp above them and apparently enjoy the process. Poor folks! they little know how their eyes will suffer. I am bound to say that they are made to appear very stupid, and they must be, to do as they are doing. Why, even the little cat in the picture has more sense! It is at least trying to shade its poor eyes with its paw!"

"The average gas poster does exactly the same thing," said the Electrical Engineer. "Indeed, the designer is usually not content with nature, but represents a naked mantle with a sort of halo of shafts of light, as if to suggest an intensity of glare to which the gas-light aspires, but which, fortunately, can never be attained in practice! High pressure gas-lighting is only comparatively recent, but, unless something is done to cover the naked dazzling mantles I should not be surprised if an impression that high-pressure gas-lighting is, must be, and always will be dazzling and glaring, is soon built up in the public mind."

"The truth is," said the Philosopher, "that the public mind is not discriminating. It knows that a certain installation is objectionable, and possibly even recognizes that it is 'glaring.' But the peculiar thing is that in many cases this glare is not connected with the fact that naked undesirably bright tources are used. The actual conditions responsible for glare are only dimly perceived and, by some abstruse process of reasoning, they are regarded as necessarily connected with a particular illuminant. In my humble dwelling nothing will induce the maids in the kitchen to use electric light, and in my last house, which was gas-lighted, they had the same prejudice against incandescent mantles. They are firmly attached to oil-lamps, though they seem incapable of explaining why they dislike gas and electric light. They merely declare that the light "is not good" though there must be quite as much as is obtainable from an oil-lamp."

"You see now," said Lumina, "that there is reason in repeating obvious declarations about dazzling. "Even experts are not all agreed as to what is dazzling and what is not.

Now take the illumination of the Court of Honour at the White City—"

"A triumph for electric lighting! What could be more effective than the fairy-like chains of incandescent lamps?" said the Electrical Engineer.

"A Court of Glaring Vulgarity I called it!" said the Gas Engineer.

The comments of the Gas Engineer and the Electrical Engineer were uttered almost simultaneously.

"They can't be both right," said the Man of Sense.

"My grandmother always sews by acetylene light," remarked the Ace-

tylene Man. "She never would hear of gas or electricity. And why? Simply because acetylene alone, among all other illuminants, is without glare."

"My great-great-great-great-grand-mother preferred candles, and she never used gas or electricity either," said the Electrical Engineer sarcastically. "But need we wonder at the vagaries of the public mind when the official mind acts in such a peculiar manner? You may remember—" (Here he addressed himself markedly to the Gas Engineer.) "You may remember that at the beginning of this interesting conversation I drew your attention to the horribly glaring installation in Fleet Street. Now what are we to think of the City authorities who desire to spread such a method of illumination? I presume they also judge the abilities of a light by looking hard at it, and seeing whether it hurts."

"The deputation that visited Germany," said the Gas Engineer hotly, "consisted of business men. A business man can see whether the general illumination is good or no at a mere glance. He does not go round poking about with photometers—"

"I see," said the Man of Sense. "You are like the Acetylene Man, 'You leave all this to the scientist and the professor!' You don't mind quoting him if he is favourable, though!"

The Electrical Engineer turned to *Lumina*: "Between you and me," he said, "there seems more need for education in the matter of glare than I thought, and I really think my two friends here would benefit by a little tuition. But — excuse me—will you tell me exactly what you call a glare, as you seem to think you know all about the subject?"

"I don't claim to know all about it by any means," said *Lumina*. "Probably one might say definitely that any illuminant so placed that its brightness was distressing to the eyes deserved to be called 'glaring.' Your statements show, at any rate, that you consider some of each other's installations to deserve this term. But the exact order of intensity above which an object can be said to be too bright to be looked at with comfort has yet to be authoritatively settled. This is essentially a physiological problem, and one on which the medical profession have a right to speak. Then again there is the standpoint of the architect to be borne in mind, for aesthetic effects may easily be spoiled by the indiscriminate use of lights of undesirably high intrinsic brilliancy. You must admit therefore, that there are other standpoints beside your own to be considered. My point is that until all those who have a right to speak on this question—engineer, architect, and oculist—are given an opportunity to express their views and to form some satisfactory conclusion, the present vagueness will remain, and misleading statements will remain too. That is why I want to see the Illuminating Engineering Society a success. You fellows ought to try and help. Well! to our next meeting!"

Somewhat to their surprise, the Electrical Engineer, the Gas Engineer, and the Acetylene Man, found themselves walking down the street in a positively amicable manner. Each felt that he had had his say and scored off the other beautifully; and each was mentally revolving strong arguments for the next meeting, with a better appreciation of his opponent. The Philosopher regarded them with renewed interest, and the Man of Sense, who had originally kept at a safe distance, now took courage and only walked on the outside edge of the pavement.

Only *Lumina* watched their peaceful departure with no sign of surprise. "Fighting," he said, "is born of fear, and fear of want of understanding."

REVIEWS, ABSTRACTS, AND REPRODUCTIONS.

The Theory of Flame and Incandescent Mantle Luminosity.

By W. H. Fulweiler.

(A paper read at a meeting of the Philadelphia Section of the United States Illuminating Engineering Society, January 15, 1909.)

(*Concluded from p.* 707.)

When a mantle is placed over a Bunsen flame, owing to the fact that the mantle is colder than the flame, there is a layer of gas molecules separating the flame from the mantle. As the velocity of the gaseous mixture passing through the mantle is increased by burning larger quantities of gas in it, the insulating layer is diminished in thickness and the mantle temperature rises; this action explains to some extent the increase in efficiency due to higher consumption of gas per unit of time. Again, with many ordinary burners the efficincey of the injector action of the mixing tube rises rapidly with increasing pressure, and the corresponding increased volume of gas delivered, so that at the high pressures at the burner tip a greater air to gas ratio is secured. The output of the gas rises as the air to gas ratio is increased—other factors being equal—until it reaches a maximum apparently, with ordinary burners, when the ratio is about 12 per cent. less than that required for complete combustion of the gas.

In considering the relative efficiencies of various gases in the mantle one should remember that the burner and mantle combined is a heat-light engine of rather low efficiency—about that of the ordinary slide valve steam engine—and that the energy delivered as light must bear some direct relation to the energy put into it as heat per unit of time, so that—as in the gas engine—it is the heat per unit volume of combustible mixture that is the determining factor, with the assumption, of course, that the air required is properly supplied in each case.

In general it is found that the air required for the complete combustion of a gas bears a fixed ration to the heating value of the gas. Casaubon[1] has found that the volume of air required for the complete combustion of 1 volume of gas multiplied by 112·9 gives the heating value of the gas in B. T. U. per cubic foot. He uses a cerium mantle and notes the ratio of air to gas when the mantle changes from red to white. Therefore, for nearly all gases the heating value per unit volume of mixture would be closely the same and the luminosity would depend on the volume of mixture burned per unit of time or the total heat energy expended.

St. Clair Deville[2] has made an exhaustive test on this point and has shown that, contrary to the earlier belief, the theoretical flame temperature is not important, but that for any given burner there is a particular rate of heat consumption per unit of time that yields the maximum or efficiency, while the maximum luminosity or intensity per unit of area will be secured at a rate from 50 to 60 per cent in excess of the efficient rate. This is quite what one should expect in general from any transformer of energy.

He found, for instance, when working with a Welsbach A burner, that the maximum efficient rate was about 3960 B. t. u. per hour, while the maximum luminosity was obtained at a rate of 6330 B. t. u. per hour.

Working with three grades of coal gas, namely, 18·3, 13·3, 4·9 candle power, he securcd the maximum luminous intensity with the medium candle-power gas, but he assumes that with a different arrangement of the burner he would have secured the maximum result with the poorer gas, as the dissociation that takes place in the richer gases limits the temperatures attainable. His maximum intensity per square millimetre was equal to 0·20 hefner

[1] *Jour. of Gas Lighting*, London, July 3, 1906 p 41.

[2] *Loc. cit.*

candles, corresponding to a black body temperature of about 1500° C.

White and Travers[3] investigated the relation between the surface brilliancy and temperature with a thoria and thoria-ceria mantle. They calculated, from measurements made over a small area, that the difference in energy transferred by the thoria and thoria-ceria mantle was equal to 576 calories per square centimetre per hour, while the difference in luminosity was 1·7 candle-power. The difference in energy was equal to 64×10^5 ergs. per second.

According to Tumlirz the mechanical equivalent of light for a hefner lamp is $1{\cdot}51 \times 10^5$ ergs. per second, so that with the observed rate of transference there should be a difference in candle-power equal to 42·0 hefners or 37·2 candles. As a matter of fact, there was 1·7 candles, or 4·5 per cent efficiency. This is nearly twice the efficiency of the hefner lamp where only 2·4 per cent of the total energy is luminous. This fact might be indicated by the reddish colour of the hefner lamp which shows the preponderance of the longer ays.

White and Travers have given a table showing their observed relation between the surface brilliancy in candles per square inch, and the observed temperatures of the mantle, which is given in Fig. 5.

Considering now the displacement of the zone of final or complete combustion of the bunsen flame (*a d e c* Fig. 6) by the influence of the mantle, it is found that as long as the temperature of the mantle is above 1400° C. the water-gas equilibrium holds at the surface of the mantle, which will, therefore, always be surrounded by a reducing atmosphere. This fact would invalidate the double oxidation theory alone if Killing's experiment showing that the mantle exhibited its luminosity while burning hydrogen in an atmosphere of chlorine had not already done so.

Regarding the composition of the mantle, the following table gives a number of oxides that have been used to envelope the luminous effect. They may be divided tnto two classes, namely, foundation or absorbents, and exciters or radiants.

Under the first class the luminosity per cubic foot of "16-candle-power" gas that they will develope in the pure state is given. However, their efficiency when used with one of the exciter oxides seems to be almost inversely proportional to their efficiency in a pure state.

The exciting oxides are ranged roughly in the order of their efficiency.

Foundation oxides.	Specific output with "16 c.-p." gas with pure oxides. C.-P.	Excitant oxides.
Aluminium ...	0·60	Chromium
Erbia	0·60	Rhodium
Thorium	1·00	Ruthenium
Zircon	1·50	Cerium
Barium.........	3·30	Gold
Magnesium ...	5·00	Iridium
Yttria	5·20	Platinum

While there are several combinations of oxides that give efficient results for a short time, nothing as yet seems able to displace the thoria-cerium combination, if for no other reason than the great stability of the latter at the temperatures involevd.

White and Russell[4] have shown the effect on the specific consumption in heat units per hour required to yield one candle-power in mantles containing varying percentages of cerium. They fell from 65 B. T. U. in a mantle containing 0·2 per cent of ceria to a minimum of 35 B. t. u. at 1·0 per cent rising again to 43 B. t. u. at 1·6 per cent.

These figures were obtained in 1901, and the specific consumptions have since been decreased to 20 B. T. U. per candle for ordinary illuminating gases, while 14 B. T. U. per candle is claimed for acetylene.

In conclusion, the author hopes he has shown that the question of luminosity in gas flames, whether open or mantle burner is not complex, and one need not seek some recondite explanation for the phenomenon. He believes that it is purely a question of high temperature and a solid radiating body modified by the fact that in the case of the mantle its radiations are strongly selective.

[3] *Loc. cit.*

[4] *Proc. Mec. Gas Assoc.*, 1902.

Illuminating Engineering Problems with Gas.

(Abstract of a paper read by Mr. Norman Macbeth, before the Detroit Convention of the Michigan Gas Association. *Am. Gaslight Journal*, Oct. 11, 1909.)

Illuminating engineering problems with gas are not materially different from those with electricity; that is, so far as concerns the calculations for predetermined results.

Owing to the ability of the eye to adapt itself to widely varying intensities of illuminations, we could in the past be assured of an approved installation where 15 to 20 foot candles were applied, although 6 would have been quite satisfactory. It is just such installations as these which are to-day going to tungsten and enabling electricity to meet gas competition on an equal cost basis. With an illumination of 5 to 6 foot candles, which comes under the heading of brilliant illumination, the gas man may figure with the same certainty as his electrical competitor.

By far the most simple method of calculation of illumination, and one which is at the same time quite as exact as those methods of greater length and complexity, is that by the use of factors based on the cubic feet of gas per hour per square foot of area to be illuminated. These factors are, of course, based on past performances in actual installations, from actual observations, and illuminometer measurements, with average good quality gas, medium, but not high pressure, and average adjustment of lamps, installations receiving the usual maintenance service.

The correct way to state these factors is, of course, on the basis of "lumens per cubic foot," or "cubic feet per foot candle per square foot." To render these factors more useful, however, they are given in terms of "cubic feet of gas per square foot" and the reciprocal of that factor "square feet of area to be illuminated per cubic foot of gas" for intensities varying from that required for good illumination to that required for brilliant illumination.

Believing that an application of these factors to completed installations would result in a clearer conception of their use than the simple outlining of rules, which at best are rarely sufficiently broad to cover the varied conditions met with in actual practice, I will refer to two typical problems in illumination.

Take first the "Steeplechase Pier," a place of entertainment devoted to mechanical amusements. The main room was formerly a dance hall, but is now used as a lobby to the theatre and as a play room for the children, both young and grown up. In addition to "Funny Mirrors," many freak mechanical pieces are placed about the floor and walls, as is usual in places of amusement of this kind.

The room proper measures approximately 64 feet by 74 feet, with a ceiling 26 feet 6 inches high, and the fixture problem should be treated in a manner in keeping with the surroundings. Small lamps could not well be used, and there are at present no lamps of sufficient size to be used singly on the outlets which were already in place and were otherwise satisfactory. General illumination, of good but not brilliant intensity, was desired, and it was decided that fixtures using the four inverted mantle cluster lamps would result in a satisfactory arrangement. The white metal ceiling and light walls fix the classification for the factors as given in the table.

On referring to this table, for Reflex cluster lamps, we have a factor of 0·04 cubic feet of gas per square foot (Column A) or 25 square feet per cubic foot of gas (Column D). The area to be illuminated, 64 times 74, equals 4,736 square feet; 4,736 times 0·04 equals 189·44 cubic feet of gas required.

I may next refer to the illumination of a shoe store—an installation of an entirely different character. In this instance, the illumination must be of sufficient intensity to permit of close examination of dark leathers and materials, and a valve designated as brilliant would be desirable.

The dimensions of this store are: Length, 52 feet 5 inches; width, 15 feet 1 inch; width between upper shelving, 13 feet 1 inch; height of ceiling, 10 feet. The ceiling is light and the walls, considering the box fronts, may also be classed as light. The area between shelving is 52 feet 5 inches times 13 feet 1 inch, equals 685·5 square feet. With Reflex lamps and prismatic reflectors, the factor to be used is 0·06 (Column B). Multiply-

ing 685·5 by 0·06 gives 41·14 cubic feet of gas per hour for the entire floor. This amount, divided by $3\frac{1}{3}$, the consumption of one lamp, gives 12·3 lamps.

With a requirement of 12 lamps, we may use 6 brackets, leaving 2 lamps for each of the 3 central outlets. This you will note is exactly half the number of lamps installed— and is actually all that is ordnarily in use. With these 12 lamps the store appears exceptionally well lighted, and from illuminometer measurements taken was found to have an average intensity of $4\frac{1}{4}$ foot candles. With all the lamps on, the illumination was as high as 14 foot candles on a plane 10 inches above the floor. It may be noted, however, that this increase was not fully appreciated by the eye ; that is to say, the difference between the brilliant results

admits of giving any particular section or sections an individual treatment—increased or reduced intensities—according to the character of the goods displayed or the purpose for which the illumination is desired. As a matter of fact, practically all large installations are but a combined number of small ones, and can only be handled in this way.

Multiply the length by the width to obtain the area. Multiply the area by the factor from Column A or B of the table corresponding to the unit selected, to obtain the total consumption. Divide the total consumption by the rated consumption per unit (see table) to obtain the number of units. The proper placing of the units thus determined upon is largely a matter of experience and judgment.

Light Units.	Factors. Cubic feet of Gas per Hour per Square Foot.	Factors. Square feet of Area to be Illuminated per Cubic Foot of Gas per Hour.
	A. B.	C. D.
Reflex lamps rated at $3\frac{1}{3}$ cubic feet per hour with clear Welsbach Holophane reflectors; mantles 8 to 15 feet above the floor	0·03 to 0·06	17 to 33
Reflex lamps rated at $3\frac{1}{3}$ cubic feet per hour with sand blasted ball globes; mantles 7 to 10 feet above floor ...	0·035 to 0·07	14 to 29
Reflex 4-mantle cluster lamps rated at 13 cubic feet per hour with alabaster globes; mantles 8 to 12 feet above floor	0·04 to 0·08	13 to 25
Upright 4-mantle arc lamps rated at 20 cubic feet per hour with alabaster globes only; mantles 7 to 9 feet above floor	0·05 to 0·1	10 to 20
Upright 4-mantle arc-lamp rated at 20 cubic feet per hour with alabaster globes and opal reflectors; mantles $7\frac{1}{2}$ to $9\frac{1}{2}$ feet above floor	0·045 to 0·09	11 to 22

NOTE.—Column A and D are for good general illumination; column B and C are for brilliant illumination. For low intensities such as are desired in warehouses, piers and locations where only sufficient illumination is required for the discernment of large objects, use $\frac{1}{4}$ of the values in column A or 4 times the factors in column D. These factors are for light ceiling and light walls. With dark walls add 25 per cent to factors A and B or deduct 20 per cent from factors C and D.

with 12 lamps in use and the effect with 24, did not appear to warrant the additional expenditure.

For the general solution of illumination problems, using the table given above, an approximate plan of the room or area under consideration should be taken, not omitting any galleries or irregular sections, height of ceilings, position of present outlets, if any, and colour of walls and ceiling.

Take the area to be illuminated, and if this is irregular, it may be divided into a number of sections, treating each one independently. The same method

Much has been said regarding the question of the height at which to hang lamps, not all of which is along the lines agreed upon by either the gas man or his consumer. Lamps with inverted mantles should be placed considerably higher than has been customary for lamps with upright mantles. It is generally conceded, and can be readily proved, that upright mantle arcs 6 feet above the working or effective plane are hung at the proper height, both as to the illumination on the floor and the ceiling; the gas man working on commonsense lines, aided by years of experience was right in placing these lamps at this

height. It can be just as readily demonstrated that lamps with inverted mantles should be hung at greater height, and for the same reasons. In this way uniform illumination is secured.

Reflex Gaslight Fixture, with Holophane Shades.
(Welsbach Co., Gloucester, N.J. United States.)

Attention to just such points as these will do much towards ensuring better results. Slightly more time may be required at first in handling installations in this way, and the average gas man is liable to feel that the old way is best; at any rate, it is easier. That may be so, but *these are not the "old days" and the gas man must keep up or fall behind.*

The tungsten lamp situation, which is not without interest to the aggressive gas man, has not been by any means settled. The central stations have, of course, largely adopted them, but rarely to a greater extent than that necessary to enable a club to keep the contractor out of the business, that they may control the installation of these lamps, and to as

great an extent as possible limit their introduction to the larger sizes. The idea is to install the tungsten lamps, not on the basis of same illumination as previously used, for one-third the amount paid, but to give the consumer three times the illumination for the same maney plus lamp renewals.

The result is that, with the adoption of the tungsten lamp, consumers of electricity are generally paying more than before for their lighting service.

This is most unsatisfactory to many consumers. I have known electric consumers of a size contributing $500 to $3,000 per year, having had free carbon renewals for years, and accustomed, therefore, to consider their electricity costs only, figuratively "go up in the air" on the burning out of a tungsten lamp costing perhaps $1, when, as a matter of fact, that particular lamp may have had a life of 1,500 hours to its credit.

Many gas men recall similar indignation on the part of gas consumers in the early days of incandescent mantles, when the mantles were fragile and expensive; the dissatisfaction was often there even after you had shown your customer that he had actually saved in gas costs several times the price of that particular mantle. In the sale of illumination, either gas or electric, the satisfying of a customer is the rock, first and last, on which either system may be wrecked or find success.

I believe I am quoting Mr. Searle, of the Rochester (N.Y.) Railway and Light Company, correctly, in a statement made at the recent N.E.L.A. convention, at Atlantic City, to the effect that "Consumers have just so much money to spend and they want light. Consumers go to gas because they have been able to get more light for their money." Mr. Searle was a gas man, but is not by any means outside the fold when the sale of electricity for illumination is a possibility.

In the sale of gas illumination, the question of electric rates should be fully and carefully studied. Your canvassers dare not make representations regarding combined gas and electric costs without a clear knowledge of the rates on which these costs are based. Salesmen of lamps, having a higher efficiency than the carbon filament lamps, have had this condition to contend with for years, and lately many cases have come to light where any lamps more efficient than the free renewal carbon filament lamp, if purchased by the consumer, would be an expense and not an investment.

Attention must be given to lamps and their position, if gas is to continue to hold the advantage.

With the open flame and many of the upright combinations, electricity may and does compete on a favourable cost basis because of their poor distribution and not because of the quantity of light which may be generated in terms of mean spherical candle-power for 1 per cent.

In this connexion I may quote the following paragraph copied from the 'Handbook' above mentioned. "Where actual figures are not propounded, it is often airily stated that 'it is a matter of common knowledge that gas is cheaper than electric light'; it might be more accurately styled a 'matter of common ignorance.' It is one of those convictions which only the evidence of annual accounts will dispel."

Gas men are very frequently cautioned by the electrical press to play fair, and to stick to what they consider favourable figures when making comparisons. Lamp comparisons are to be made only when the electric lamps are equipped with the most efficient light distributors available, though but a small percentage of such lamps in actual use may be so equipped; also, when discussing light output from electric incandescent lamps *v.* gas incandescent lamps, to bear in mind that mantles depreciate with life. Of course, they do, but the fact that many of the electric incandescents have ceased to be useful after 300 to 500 hours, does not warrant a comparison being made on the basis of initial or laboratory performance of the electric *v.* gas incandescent mantles after 1,000 hours of life, nor is the renewing of mantles each 150 hours warranted by common practice, although same was evidently necessary in a very elaborate cost table given recently on 'Incandescent Gas Light *v.* Tungsten,' in one of the highest rated electrical manufacturers' trade publications.

Just as constant dropping will wear the stone, so is the public being affected by this "matter of common ignorance." The correction is in your hands, and, as stated in the last line of the paragraph above quoted and here repeated, "It is one of those convictions which only the evidence of annual accounts will dispel."

Programme of the Association of Engineers in Charge, 1909-1910.

We have received from the Association of Engineers in Charge (St. Bride's Institute, Bride Lane, Fleet Street, London, E.C.) the programme for the coming session. A varied and interesting series of papers has been arranged. The Session commenced with the address of the President Mr. Henry Adams on 'Standardization,' and in addition to the social events, the following papers will be presented :—

Dec. 8th, Konrad Anderson and E. Meden on 'Recent Developments in Impulse Steam Turbines.'

Jan. 12th T. W. Aldwinckle on 'Heating and Ventilating of Public Buildings.'

Feb. 9th, A. Angold on 'Modern Arc-lamps and their Application.'

March 9th, J. Abady on 'The Application of Recording Instruments to Steam Generation.'

April 13th, R. I. Wallis-Jones on 'Welding and its Application.'

We are also informed that Mr. A. E. Penn has been elected Chairman of the Council of the Association.

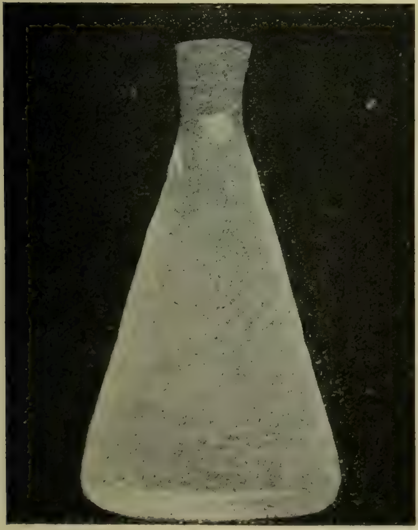
Electricity for Everybody.

An Exhibition of Electrical Heating and Lighting Appliances promoted by the Boroughs of Shoreditch, Hackney and Stepney.

The above exhibition was opened by Mr. Wm. Mordey, the President of the Institution of Electrical Engineers for the past year, on Monday, October 21st.

At this exhibition illumination was naturally well represented, the latest types of Osram and Tantalum high-voltage lamps being shown, and also a variety of fixtures, including Holophane "arcs" and designs of the Bromsgrove Guild. As it happened the lamps on exhibition were somewhat severely tested. Mr. Mordey's address was punctuated by a report, caused, our representative was informed, by the voltage being, through some mistake, temporarily raised to twice its normal value. Nevertheless, many of the lamps withstood the instantaneous rise in P.D. without suffering any apparent ill-effects—a condition of affairs which could hardly have been looked for had carbon filament lamps been in use.

A collection of electric appliances for heating and cooking, running sewing machines, and refrigorating plant, hair-brushing, and horse-clipping, and other purposes, served to show the variety of uses to which electricity can now be applied.



A Phosphorescent Source of Light.

A recent number of *Popular Mechanics* refers to some work of Prof. Molisch of the University of Prague, who has devised a form of "cold lamp," depending for its action on the phosphorescent luminosity of living organisms. Prof. Molisch, it is stated, has succeeded in preparing a glass flask filled with sterilized gelatine and vaccinated with a culture of luminous bacteria which yields a considerable amount of light; although of less intensity than a small candle, it is said to suffice for many scientific and photographic purposes.

The adjoining figure shows the appearance of this lamp photographed by the aid of its own light.

Methods of Determining the Amount of Light Scattered from Rough Surfaces.

By Prof. W. F. Barrett, F.R.S.

From the Scientific Proceedings of the Royal Dublin Society, July, 1909, Vol. XII., No. 18.

In this paper Prof. Barrett seeks to investigate the measurement of the amount of light reflected from rough surfaces. Reflection of this nature, he points out, may vary with the angle of incidence, a little light being also absorbed even by the whitest surfaces. He points out, moreover, that the amount of light scattered, by large surfaces of this kind, such as buildings or whitewashed walls, is of great practical means and especially so in legal disputes where a case of ancient lights is concerned. Some experience in connexion with matters of this kind, in which the estimates and the method of observation, the author states, appeared untrustworthy, led him to investigate the above question.

In discussing possible methods of approaching the problem Prof. Barrett remarks that the inverse square law cannot strictly be utilized in the case of large reflecting surfaces. Among other possible methods he suggests the well-known rotating sector method. The system which he has employed in these experiments, however, involves the reduction of the intensity of the stronger light by a suitable absorbing medium. For this purpose a liquid of neutral tint is wanted, and such a liquid, the author states, is best formed by a slight mixture of Indian ink in water which is allowed to stand for 48 hours ; the coarser particles are then deposited and the liquid remaining is employed.

The amount of light scattered from various large surfaces is then compared by the relative depth of light required to produce extinction. This point of extinction depends to some extent upon the condition of the eye, but it was found that after one minute the eye attained a fairly steady state.

In one series of experiments a minute photograph of the graduated test type used by oculists was viewed by the observer through an adjustable depth of the liquid. The depth of liquid required to produce the complete extinction of *light* is regarded by the author as a measure of the "intrinsic brightness" of the source. When, on the other hand, he measured the depth of liquid required to obscure and produce illegibility of the test type the author regarded the test as measuring the "illuminating power" of the source of light in terms of visual acuity.

The following table gives the results of some observations obtained by such means. Calling the depth of liquid 100 when a silvered reflector is employed, the percentages indicate the depth required to render the type of a given standard size illegible, in the case of each of the surfaces named.

Silvered mirror	100
Plane glass surface	65
Ground glass	45
White card	45
Grey card	35
Dark grey card	21
Smooth black paper	20
Black cotton cloth	16
Dull black woollen cloth	5

When, instead of finding the depth of the neutral tinted liquid required to obscure the reading of the type, the author measured the depth required to extinguish the light scattered from various surfaces, he found that, even with dark surfaces such as black paper or cloth, the intrinsic brightness (according to his definition) was not reduced more than 40 per cent, although the illuminating power was reduced 80 or 90 per cent. This method of observation he considers to be a possible application to the somewhat difficult problem of the relative value of different systems of lighthouse illumination ; for in such cases it is the distance at which the source can be seen that is important, and not its power to illuminate. The author also recognizes that the test described involves the sensitiveness of the region of the retina of the eye used, and he further suggests that the method might be used as a means of studying the qualities, as regards perception of light and form, of d fferent portions of the retina.

The Downward Tendency in Candle-Power of Electrical Incandescent Lamps.

(From *The Electrical Times*, October 7th.)

In a recent number of *The Electrical Times* attention is drawn to the persistent evolution of electric incandescent lamps towards low candle-power units. This development, it is pointed out, may be expected to proceed on lines almost identical with that of the incandescent mantle, and it is wonderful to recollect that but a few years ago the high voltage metallic filament lamp was regarded as impracticable. In this connection our contemporary goes on to remark:—

"When the single carbon filament to burn on 200 to 250 volt supplies became a commercial article it was only a matter of time before the units of light were reduced, and to-day the $2\frac{1}{2}$ c.p. high voltage carbon lamp can be obtained at any store. Who shall say that in a few years' time similar progress will not have been made with the wire filament? The rapidity with which the drop in the candle-power limit has been maintained since the wire lamp was first brought forward seems to justify the belief that the minimum size has by no means been reached. It was on April 1st of last year that the high voltage Osram lamp was first listed, the original type giving 50 c.p. at 200 volts for a consumption of about 63 watts. In rapid succession the 40 c.p. 50 watts and the 32 c.p. 40 watt h.v. Osram lamps were introduced, and the General Electric Company now announces that it can give immediate delivery of the 32 watt 25 c.p. Osram lamp for 200–260 volt circuits, which, rated in accordane with the British Standard, gives 22 candle-power. The latest Osram lamp has, therefore, an efficiency of 1·42 watts per British candle and 1·26 per Hefner, approximating closely to that of the earlier high voltage patterns which have proved so successful in practical use. Other types of tungsten lamps have been produced in smaller units for high voltages, and we have already referred to the 16 candle-power 200–260 volt Stearn lamp of English manufacture, but we understand that this cannot yet be delivered in commercial quantities. The 22 c.p. h.v. "Metalik" lamp has, however, been on the market for a month or two, and seems in every way a satisfactory article. Before the present lighting season draws to a close, and very likely this side of Christmas, G. M. Boddy & Company hope to be in a position to deliver 'Metalik' lamps for 200–260 volt circuits which will give as low as 10 British candles, the 16 candle-power pattern being already well within sight. It is expected that the 10 candle-power lamp will consume no more than 15 watts."

Obituary.

We regret to record the death of Mr. C. J. Robertson, the engineer and manager of Robertson Electric Lamps, Ltd., which occurred on Wednesday, October 6th; the funeral took place on October 9th, the first portion of the service being conducted at St. Peter's Church, Ealing, when many of the staff of the Robertson factories were present.

Mr. Robertson's name will be permanently associated with the development of the electric lamp industry in this country, and he will be remembered not only as one of the earliest experimenters in this field, but also as a persevering worker, who did much to bring the manufacture of electric glow-lamps to a commercial stage.

Mr. Robertson was associated with Mr. Lane Fox in his researches from 1879 to 1881; subsequently he held positions on the Continent and in 1893 he established, with the help of the General Electric Company, the Brook Green Works; with every development of this industry since that date he was intimately associated.

With a quiet and unassuming manner Mr. Robertson combined considerable intellectual gifts, and his friendship was highly valued by all those who knew him.

TRADE NOTES.

[At the request of many of our readers we are extending the space devoted to Trade Notes, and are open to receive for publication particulars of new developments in lamps, fixtures, and all kinds of apparatus connected with illumination.

The contents of these pages, in which is included information supplied by the makers, will, it is hoped, serve as a guide to recent commercial developments, and we welcome the receipt of all *bona fide* information relating thereto.]

The "Degea" Airostat Inverted Burner.

We have received from **Messrs. Julius Norden, Ltd.**, 44, Farringdon Street, London, E.C., particulars of the "Airostat" regulating arrangement which is used with the new "Degea" type of inverted burner. A representative of this journal recently called at the offices of this firm, and had an opportunity of seeing this arrangement in action.

Briefly, the intention of the Airostat regulator is stated to be to allow for the difference in the working conditions which are characteristic of the inverted incandescent burner when it is first lighted, and those which prevail when it has been burning for some minutes; owing to the change in temperature of the burner, the best proportions of gas and air in the two cases may not be the same. As a result it has been found that when inverted burners are first lighted there is sometimes a tendency for a hissing noise to occur. In addition, if the air supply is increased beyond a certain point, there is some danger that the burner may "light back," though these defects may disappear after several minutes' burning. If, on the other hand, matters are so arranged that the burner starts under the most favourable conditions it may be found after some minutes that it is no longer burning satisfactorily; the flame smokes and the maximum illuminating efficiency of the mantle is not attained.

Now, by the use of the Airostat regulator the access of air to the burner is automatically altered as the burner becomes heated. When the burner is cold the Airostat (which consists of a double flexible clip made of a special alloy with a high temperature coefficient of expansion) assumes the position shown in Fig. 1. In this position the airholes are covered, but yet the access of air is not entirely restricted. As the burner heats up, and a more copious supply of air becomes desirable, the expansion of the airostat uncovers the air-holes as shown in Fig. 2; this, it is claimed, enables the most perfect conditions of combustion to be always automatically attained. The time that is required for a steady state of affairs to be reached naturally depends somewhat on the nature of the fitting; as a rule it varies from four to ten minutes.

Another incidental benefit claimed for the use of the Airostat regulator is that the access of dust into the interior of the burner is very greatly restricted during times when the burner is not in use; this is regarded as a distinct advantage in factories, etc., where a more or less dusty atmosphere is inevitable. In addition special provision is made for the prevention of the collection of dust in the burner by the use of a small trap above the needle regulator (shown at *a* in Fig. 4). This regulator is also of special design, and is intended to enable the pressure to be regulated to a desirable value irrespective of the local gas-supply.

In this connection yet another advantage has been claimed for Airostat control. Owing to the differences in the local pressure and quality of gas in different districts and countries, it has sometimes been found that a burner which works admirably in one place proves much less satisfactory in another, simply because it cannot easily be adjusted to suit altered conditions. The Airostat regulator, however, automatically controlling as it does the proportions of gas and air, is calculated to remove this difficulty, and in proof of this suggestion it is stated that the Airostatically controlled "Degea" burner has been utilized for long periods of time all over the world and was found to answer equally well in all localities.

In Fig. 4 the gas regulator is shown at *a*; *b* is the Bunsen tube, and *c* the air-regulator which is partially covered by the Airostat *d*; *e* is the mixing tube, *g* the mouthpiece of the burner composed of special hard and heat-resisting material from which the mantle *h* is suspended. The inner globe surrounding the mantle

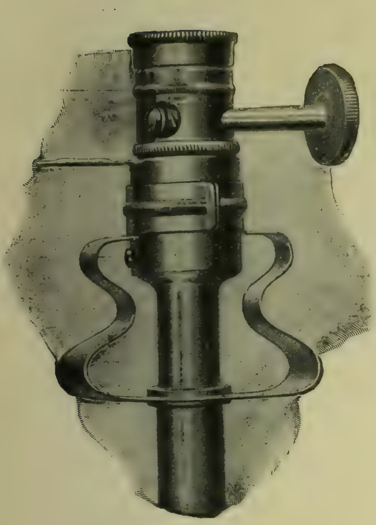


FIG. 1.—Airostat Regulator closed (Burner cold).

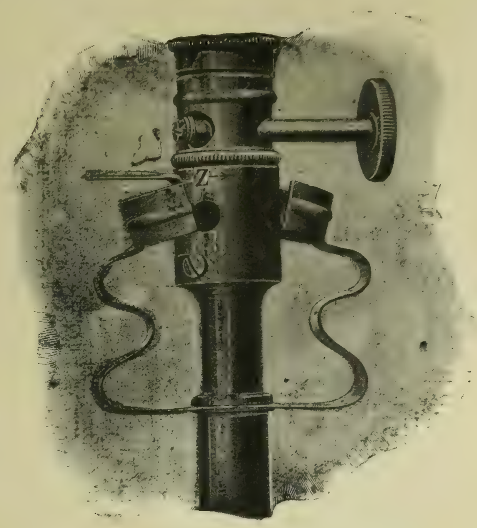


FIG. 2.—Airostat Regu'ator open (Burner warm, after burning several minutes).

FIG. 3.—Degea Burner with Airostat, general view.

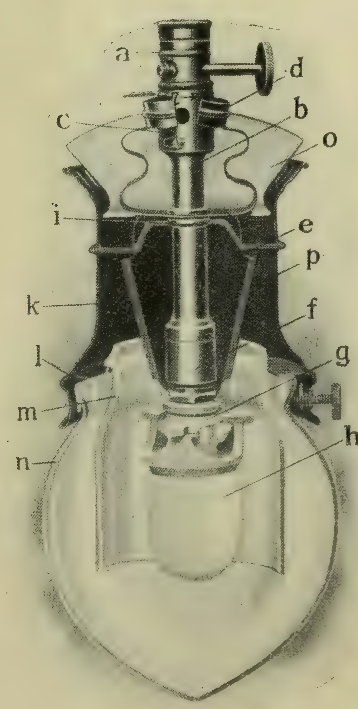


FIG. 4.—Degea Burner with Airostat, sectional view.

is indicated by m and the outer diffusing shade by n; naturally, however, different types of outer globes can be utilized.

The following particulars have been published regarding the performances of the three different sizes of "Degea" burners; but it is stated that these are, of course, only to be regarded as approximate, and naturally vary somewhat according to the local pressure and quality of gas, though, as has been stated, the burner is intended to produce the best conditions that the local supply renders possible:—

	Candle-power	Estimated Gas Consumption.
Normal Burner, C	100	$3\frac{1}{3}$
Jewel ,, N	55	$1\frac{3}{4}$
Dwarf ,, Z	32	1

A New Type of Gas-Lighter.

Another interesting development in connection with incandescent gas lighting which is on view at the premises of Messrs. Julius Norden, Ltd., consists of a new cerium-iron gas lighter.

Many attempts have been made in the past to manufacture gas igniting arrangements based on a spark produced electrostatically, but these have not proved commercially successful. It has, however, been known for some years that a mixture of cerium and iron, when rubbed, will give out a spark, and this new gas-lighter depends on this principle, the original discovery of Dr. Auer von Welsbach.

By a slight twisting movement a pellet of this special mixture, fixed at the end of a brass tube, is vigorously rubbed and produces a spark which kindles a stream of gas immediately. It is stated that a single pellet will suffice for 6,000 flashes before it is rubbed away; all that is then necessary is to insert a new pellet of the cerium-iron mixture in the existing holder, which is quite easily done.

We understand that the arrangement has at present given satisfaction, although Messrs. Julius Norden have only been experimenting with it in this country for a short time as yet.

Special Types of Electrical Fixtures.

We have received from **Messrs. Jesson Birkett & Co., Ltd.** (27, Ely Place, Holborn Circus, London, E.C.) a list of some designs of electrical fittings. We understand that the Company design fittings for use with gas, electric, and acetylene, and that they make a practice of preparing special artistic models, to suit existing installations or in harmony with particular architectural styles, their aim being to combine good workmanship with "Sanity of Design."

In these designs the artistic aspect is intended to predominate. In Figs. 1, 2 and 3 will be seen a rather unusual type of wall bracket. The frosted glow-lamp can be exposed and utilized in the ordinary way as a side-wall fixture, or one or both of the curtains can be drawn, screening the lamp and softening and dimming the light. Naturally the introduction of a silk curtain in this way must entail a certain sacrifice of light, but in many cases in which the decorative appearance of the fixture is the chief item to be considered, this is not regarded as very important. The use of tasteful coloured silk curtains in conjunction with harmonious and artistic metal-work is said to be very effective.

Fig. 4, again, represents a type of decorative lantern fitted with Albetti glass.

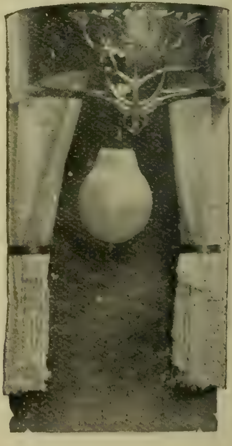


Fig. 1.

The catalogue before us also contains some unusual types of table lamps; some of them rely upon silk shades, while others depend on frosted glass, &c.

FIG. 2.

FIG. 3.

Other Publications received:—

The Electrical Co., Ltd. (Charing Cross Road, London, W.C.).—Lift controllers; single, two, and three-phase induction motors; latest price list of "Aegma" metallic filament lamps.

Messrs. Siemens Bros., Dynamo Works, Ltd. (Tyssen Street, Dalston, London).—New folder illustrating "Tantalum" lamps.

British Electric Plant Co., Ltd. (Alloa, Scotland).—Standard fourpole motors and dynamos, multiphase motors and dynamos, etc.

British Prometheus Co., Ltd. (109, Oxford Street, London).—Electric heating and cooking apparatus.

The Linolite Co. (32, Victoria Street, London, S.W.).—Particulars of the "Tuholite" lamps and reflectors.

Msssrs. Boddy & Co. (15, Gray's Inn Road, London).—Particulars of latest improvements in metallic filament lamps, including:—

16 c.-p. 100 to 130 volts at 2*s.* 9*d.* each.
25 c.-p. 200 to 260 volts at 4*s.* each.

Aron Electricity Meter Co. (80a, Salisbury Road, Kilburn, London).—Descriptive pamphlet of Aron Maximum Demand Meter.

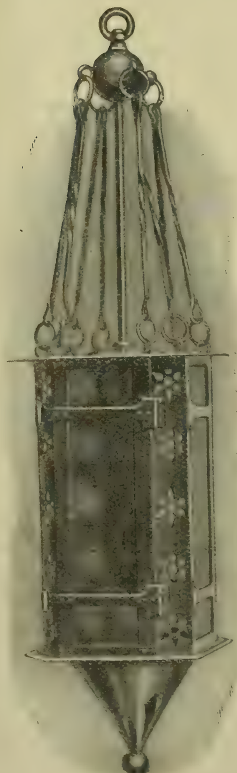


FIG. 4.—Ornamental Lantern.

British Thomson Houston Tungsten Lamp Fittings.

We have received from the **British Thomson-Houston Co.,** 83, Cannon Street, London, E.C., some particulars of the latest type of B.T.H. Tungsten lamp fittings, which are specially intended for use with high candle-power tungsten lamps and for the lighting of large areas.

The general appearance of the fixture will be gathered from Fig. 1, but they are also made with a bracket when required. The fittings can also be made of copper or zinc but the standardized finish is an oxydized copper cover; the globes usually consist of flint glass ground on the inner surface.

Fig. 1.—B.T.H. Tungsten Lamp Fitting.

"Leuconium" Lamps.

Stearn Electric Lamp Co., Ltd. (47, Victoria Street, London, S.W).—Particulars of high voltage carbon and metallic filament lamps; among the latter we note the listing of the "Leuconium" metallic filament lamps of low candle-power and power-consumption, including 25 watt, 16 candle-power (English) types for 200–220 volts.

Part of the English Tantalum Lamp Works, Dalston, London, N.

CORRESPONDENCE.

The Sand-Blast Analogy of Distribution of Light.

DEAR SIR,—In a recent number of this journal (Sept., 1909, p. 647), "Athos" seeks to show that my explanation of processes of illumination on the basis of the Sandblast Analogy is not strictly correct. He points out that the thickness of the layer of sand deposited on the walls of a sphere depends on the period of time during which the sandblast is in action; but the intensity of illumination remains the same irrespective of the time, so long as we have to deal with a steady source of light.

Actually, however, this circumstance is borne in mind in the analogy which I have suggested. At the commencement of my article (*Illuminating Engineer*, August, 1909, p. 516). I explained the conception of "output of light" during a given interval of time, and thus proceeded to the analogy of the amount of sand thrown out by the sandblast during the same interval. Next, in order to represent the "flux of light," *i.e.* the output of light during a unit interval of time, we are naturally led to consider the action of a sandblast during the same interval; on this assumption I then proceeded to the explanation of the other terms connected with light-intensity and illumination.

On this basis the analogy becomes strictly correct, and has the incidental advantage of being applicable to the behaviour of sources of light which fluctuate in intensity from time to time. Therefore, it seems to be unnecessary to adopt less concrete and less readily pictured effects such as the pressure of a steam-jet on an elastic surface, &c.

Believe me, yours truly,

DR. L. BLOCH (Berlin).

A Name for the International Unit.

DEAR SIR,—I have noted with interest M. Blondel's suggestion in the August number of *The Illuminating Engineer* with regard to a name for the international unit, and I appreciate his statement that such a term as international candle is open to objection on the ground that the word "candle" is essentially different in various languages. Mr. Patterson, arguing from the analogy of the "international ohm," sees no objection to the use of "international candle"; but while the term "ohm" is common to the different European languages, "candle" is not.

At the same time I think that history shows us that in this matter it is desirable to move with special caution in order to avoid any possible source of international jealousy. For this reason, while fully recognizing the valuable and historic work of M. Violle, it seems to me at present preferable to avoid attaching to the international unit the name of any scientist, however eminent. We have recently had occasion to note that the feeling with regard to the merits of the standards in use in different countries is still very keen, and it seems expedient to abstain from any course which might foster chauvinistic feeling.

On this ground M. Blondel's suggestion that a Greek word such as "Phos" or "Pyr" should be selected seems to me the better plan. In addition it will, I think, be very generally felt that the present compromise, valuable and convenient as it is, is only a step towards the ideal international unit, and it would perhaps be better to defer the definite acceptance of a term to describe the unit until this happy state of things has been brought about.

I am, yours truly,

ATHOS.

Dear Sir,—I have just read Mr. Paterson's interesting letter, in the October number of *The Illuminating Engineer*, dealing with the international unit of light. I notice one point therein touching the value of the bougie decimale, which I should like to make clear to the readers of your journal.

On referring to the decision of the Geneva Congress of 1896 it will be found that the bougie decimale was not asserted to be equal to the Hefner; it was only suggested that it could be provisionally regarded as industrially equivalent. This decision was based on a photometric comparison with one of the early Hefner lamps, constructed in 1891,* *i.e.*, previous to the issue of the Reichanstalt specification. Unfortunately this result has been given widespread publicity, though it has never been confirmed by subsequent experiments. But can this old and erroneous estimation be said to reflect upon the exactitude of the bougie decimale? I do not think so.

On all the other points raised I find my self in accord with Mr. Paterson, and, in my opinion, it is desirable to await the time when we shall be in a position to propose a satisfactory international standard before attempting the solution of the question of a new name.

Believe me, yours faithfully,

F. Laporte.

(Sous Directeur du Laboratoire Central d'Électricité).

* See Congrès International d Electricité, "Photometrie" by Violle, p. 34.

Dear Mr. Gaster,—The interesting criticism of my note on the above subject by Mr. C. C. Paterson (*The Illuminating Engineer*, October, 1909, p. 719), calls for several comments on my part.

1. The proposal to give the international unit of light a special name (such, for example, as "pyr" or "phos" or the name of some great authority on photometry like "Violle"), has nothing in common with the question of the value of standards of light in general nor with the value of the Violle standard in particular.

There is no more connexion implied between the platinum standard and the name "Violle," applied to the unit, than there is between the name "Ohm," as a *unit* of electrical resistance, and the nature of the accepted *standard* of resistance; this name is used simply as a recognition of the work of Ohm in establishing the fundamental laws relating to the electric current. In the same way the name Violle was suggested solely with the object of doing honour to one who has done much for the subject of photometry.

2. It is the general rule in the nomenclature of physical quantities to utilise either a Greek term, as in the C.G.S. units or, more especially in the case of practical units, the name of some celebrated man. I am not aware of any argument which can be advanced to explain why we should depart from this practice and adopt an expression denoting a material object solely in the case of the unit of light; and especially when, as I have shown, this term is necessarily differently expressed in the various languages involved

I could only regard as logical the use of the term "international candle" in English and "bougie internationale" in France, if electricians were in the habit of calling the unit of electromotive force a "pile internationale" and an "international battery" in the two respective countries.

3. In my opinion it is both unjust to the technical and general public, and also argues a lack of knowledge of human psychology, to suggest that it would be difficult to induce either to adopt a special name describing luminous intensity.

On the contrary, I believe that if one was to explain to the public that (for the sake of example), "Electricians use the term 'pyr' instead of candle as applied to electrical lamps; thus a lamp of '25 pyrs' means a lamp giving a luminous intensity equivalent to 25 candles," the public would immediately begin to use this term, owing to

the same mental peculiarity which leads it to adopt with zest so many new or foreign words to describe familiar objects in order to "show off" and display acquaintance with the most up-to-date developments!

I also appreciate your courtesy in giving me the opportunity of studying the judicious letter of "Athos" on this subject, and am in full agreement with the essence of his conclusions; what I mainly desire is a decision against the present vicious system of terminology and the establishment of phraseology in accord with the true rules of scientific nomenclature. This could be taken as applying to the existing provisional unit.

Believe me,

Yours faithfully,

A. BLONDEL.

Chief Engineer of the Lighthouse Service in France.

The Blondel-Krüss Mesophotometer or Integrating Photometer.

DEAR MR. GASTER,—With reference to the account published in your Journal (Oct., 1909, p. 710) of the integrating photometer devised by Dr. Krüss, whose work in connection with photometry is well known and deservedly appreciated, I should like to recall that the arrangement referred to was previously described by me in detail in a communication to the Société Internationale des Electriciens (Bull. de la Soc. Int. des Electriciens, Second Series, Vol. IV, No. 39, Fig. 1).

The author of this paper has made courteous allusion to an old form of rotating-sphere photometer which I have described under the name of "mesophotometer" (*l'Eclairage Electrique*, 1896, Vol. VIII, p. 49); Dr. Krüss, however, will find that in a more recent form described in 1904 the globe was replaced by a series of small lenses with suitable diaphragms; this apparatus might, therefore, more fitly be termed the "Blondel-Krüss" integrating photometer.

I may add that the arrangement of the lenses indicated in Fig. 3 p. 711 in the number of *The Illuminating Engineer* to which reference has been made, is apt to lead to errors owing to the images projected on the screen not having a uniform brightness—a condition which is only met with a source of light which is evenly bright all over. The only safe method of arrangement is that shown in Fig. 2; this yields a sufficiently bright illumination with suitable opaline glass (such as the "albatrine" of Baccarat).

Finally it may be mentioned that the apparatus can be constructed not only with a semi-circular series of mirrors, as shown in the illustration in this article, but also with a complete circle. This enables us to study the distribution of light both above and below the horizontal and to measure both $I_{\ominus}$ and $I_{\triangledown}$.

I am, yours faithfully,

A. BLONDEL,

Chief Engineer of the Lighthouse Service in France.

A Lecture on Illumination at London Institution.

A LECTURE entitled 'Modern Methods of Illumination' will be delivered by Mr. L. Gaster, Editor of *The Illuminating Engineer*, at the London Institution, on Monday, November 22nd, at 5 P.M. The lecturer will deal with the latest developments of the chief modern illuminants, and give some of the experiences of his recent visit to the Continent.

REVIEWS OF BOOKS.

KONSTRUKTIONEN ELEKTRISCHER BOGENLAMPEN.

By E. Bohnenstengel.

(*Friedrich Enke, Stuttgart,* 1909.)

In the preface to this work the author draws attention to the enormous recent developments in gas and electric lighting which have led manufacturers to bestow special pains on the simplification and cheapening of different types of lamps. A special field for such improvement obviously existed in the design of the mechanism and details of electrical arc-lamps, and the present work treats this subject in an exceptionally exhaustive manner.

This is the second edition of the work and an attempt has been made to bring the material more up to date, and to place at the disposal of the engineer interested in the technical details of the subject a comprehensive summary of the chief devices used in the past, and the more recent designs of the last few years. The book contains about 300 pages, and the very liberal allowance of 430 illustrations; naturally in a work of this class plentiful illustrations are very desirable, and it is satisfactory to find the figures clear as well as frequent.

In addition it may be noted with satisfaction that reference to the name of the firm or inventor of a particular type, or to the patent is invariably made. The reader interested in a particular type is thus informed where fuller details are obtainable if he desires more explicit information. As the book is clearly intended mainly for readers well versed in the technicalities of the subject, and the subject-matter is necessarily very condensed, this feature is one which deserves special commendation. The book is concluded by a list of the most recent German patents on the subject, and is followed by a name index to firms and patentees.

The book deals with a specialized technical subject, on which information in a convenient form is not always readily obtainable, and seems to be cast in a shape convenient for rapid reference. We do not doubt that it will be found of considerable value by those who wish to gain a survey of the existing patent literature on arc-lamp mechanisms, &c., and who also desire to have at their disposal a guide enabling them to get access to fuller information on points of detail.

PRIVATE HOUSE ELECTRIC LIGHTING.

By F. H. Taylor.

(*Percival Marshall & Co.*, 26–29, *Poppin's Court, Fleet Street, London, E.C., price* 1*s*.)

In the preface to this little book the author expresses the hope that, while not intended primarily for engineers, the work may yet be of service to those who possess a certain amount of technical training, but wish to gain some idea of what constitutes good practice in private house lighting. It is probable that this class will find the book of the greatest value for conditions of space naturally preclude the possibility of very detailed explanations on elementary points for the benefit of the absolutely non-technical reader. The book, however, is written in a precise and simple manner, and should be useful to those who require to get a general and preliminary knowledge of the subject.

The eleven chapters deal in order with the following subjects: Systems of Supply, Systems of Wiring, Conductors and Jointing, Arrangements of Circuits, &c., Arrangements of Lamps, Switching Arrangements, Testing of an Installation, Accessories, Fittings, and Lamps, Cost of Installation Work, Cost of Using Electric Light, Generating Plant. It is satisfactory to find that the author, in chap. v., lays special stress upon the desirability of keeping bright lights out of the field of view.

If we might make a suggestion it would be that, in a future edition, the author might profitably deal more fully with the choice of shades and reflectors, &c., a matter which is entitled to rank as of considerable importance to the householder in enabling him to distribute his light to the best advantage. A few words on this point would add to the value of a serviceable little book.

Review of the Technical Press.

THIRD ANNUAL CONVENTION OF THE ILLUMINATING ENGINEERING SOCIETY.

The papers read at the Convention of the Illuminating Engineering Society on September 25th, 26th, and 27th form the most important item of the past month, but cover too wide a ground to be touched on in detail in this review. A full list of these papers and an abstract of the proceedings will be found on p. 747.

The Convention is also referred to in most of the American papers; particulars will be found in the list of references following this review.

ILLUMINATION.

Many of the chief American gas and electrical papers have also editorial notices on the HUDSON FULTON CELEBRATION which took place simultaneously. A feature of the celebration was the lavish use of electric light for decorative purposes, one special device being the prismatic searchlight of Mr. Ryan. The beams from search lights are projected so as to illuminate clouds of condensed steam. By the use of colour diaphragms various tints can be given to the light.

A number of other articles of considerable interest have appeared in American papers. Thus **H. E. Ives** (*Illuminating Engineer*, N.Y., Sept. 23rd) deals with DAYLIGHT EFFICIENCY OF ARTIFICIAL ILLUMINANTS. He gives tables and diagrams representing the relative intensities of various artificial illuminants in different parts of the spectrum, compared with that of daylight. **P. G. Nutting** (*Elec. World*, N.Y., Sept. 23rd) deals with LUMINOSITY AND TEMPERATURE and endeavours to study the complete mathematical connexion between radiation phenomena and physiological effect.

A. A. Wohlauer (*Elec. World*, N.Y., Sept. 16) discusses METHODS OF SPACING LIGHT UNITS in an interior so as to provide uniform illumination. He suggests that this can be expressed by formulæ independent of the polar curve of the illuminant or its distance above the ground, within certain limits. These two factors are selected according to local conditions.

Another article on similar lines is that of **W. D. Cooper** (*Elec. World*, N.Y., Sept. 23) who discusses SYSTEMS OF ILLUMINATING TUBES (*e.g.*, Moore tubes, &c.), and shows how such systems can be contrived to give a very uniform illumination. He also discusses the error in the photometry of such tubes involved in applying fundamental photometrical laws which are only intended for point sources.

Among other papers dealing with general illumination we may mention again the Cantor Lectures by **L. Gaster** the editor of this journal, an abstract of which is given in *Nature* (October 21). In a recent presidential address before the Association of Engineers in Charge, **H. Adams** dealt with STANDARDIZATION, making special reference to the subject on standards of light; he gave some particulars of the Helium tube standard suggested by Mr. P. G. Nutting, of the Bureau of Standards, which, however, is only in the experimental stage.

One matter which is receiving considerable attention in various papers has been the action of the Local Government Board with regard to the lighting of Finchley. It is suggested that if this authority means to make definite regulations regarding street lighting, suitable expert advice and experimental laboratory facilities are needed to support its views.

PHOTOMETRY.

Several articles deal with the question of the STANDARD OF LIGHT. **J. P. Hart** (*Elec. Rev.*, Sep. 25) discusses the possibility of an absolute standard on the basis of the combination of three monochromatic sources as suggested by Dr. Steinmitz and points out several respects in which this principle is open to objection. For instance the white light so produced is not physiologically identical with that produced by a continuous spectrum.

A. A. Perrine (*Elec. World*, Sept. 15) describes some EXPERIMENTS ON A SMALL GLOBE PHOTOMETER, and gives a curve illustrating the effect on the constant of placing a source of light in different positions within the globe.

G. C. Shaad (*Illuminating Engineer*, N.Y., October) gives a brief description

of a Portable Photometer for measuring the intensity of street light sources, and gives some results obtained by its use.

ELECTRIC LIGHTING.

Many articles have appeared dealing with Metallic Filament Lamps; thus an editorial in *The Electrical Review* of New York (Oct. 9) suggests that the application of Tungsten lamps for street lighting has not led to any reduction in the income of supply authorities nor need it do so. A recent number of *The Electrical Times* is devoted to Domestic Electrification; it contains a series of articles in incandescent lamps and their use. *The Electrician* (Oct. 15) gives a résumé of last year's progress in the application of Metallic Filament Lamps for Street Lighting.

The Electrical Times has also an article summarizing the recent progress in the direction of producing metallic filament lamps of small candle-power (Oct. 7). Special attention is given in several journals to the decision of the Welsbach Co. to supply electric glow-lamps.

Special mention may also be made of a valuable résumé of recent patents on glow-lamps and arc-lamps (*Elek. und Masch.*, Oct. 3, 10). Among articles of a more scientific nature we may note that of **A. C. Jolley** (*Electrician*, Aug. 13, 20), who discusses the radiation phenomena underlying glow-lamps and gives an estimate of the temperature of various filaments. **H. Chretien** discusses the law connecting light and temperature of filaments, stating that the former is proportional to the twelfth power of the latter.

There are several articles on arc-lamps. **J. Rosemeyer** (Schweiz, *E.T.Z.*, Oct. 9) describes the "Conta" Arc-Lamp, a distinct feature of which is the simple form of mechanism. Particulars have also been given of a type of deposit-free globe for flame arcs brought out in Germany.

GAS, OIL, ACETYLENE, LIGHTING, &c.

Several papers read before gas associations in the United States have laid stress on the need for the Study of Illuminating Engineering by Gas Companies. Thus **N. Macbeth,** in a paper before the Michigan Gas Association (*Am. Gaslight Jour.*, Oct. 11) says that the conditions of illumination in interiors lighted by gas ought to be more scientifically worked out and also insists upon the necessity of gas representatives having at their disposal full details and accurate and well-presented statistics as to what their system of lighting can accomplish.

H. T. Owens (*Am. Gaslight Jour.*, Sept. 20) gives some experiences of his continental visit and points out several respects in which the United States is learning from European practice, notably in using high pressure gas lighting.

Several recent publications deal with the question of the Best Quality of Gas for Incandescent Illumination. Thus a paper by **Dr. Bunte** on this subject is reproduced in *The Journal of Gaslighting* (Sept. 28). The same journal has an editorial on the matter in a later issue (Oct. 12). In this connexion mention is made of the Bill before Parliament for simplifying the existing legal systems of gas-testing by the general use of the "Metropolitan" No. 2 burner.

A recent number of *The Plumber* contains a translation of the paper on incandescent gas lighting by **Lebeis,** to which reference has been made in a previous number of this review. This paper, it will be recalled, makes special mention of the "Airostat" type of burner. This is also referred to in several other journals (*G.W.*, Oct. 2, *J.G.L.*, Oct. 12, &c.). The device consists of a metal clip which, when the burner is cold, partially covers the air-holes. As the burner heats up this metal piece expands and uncovers the holes, thus admitting more air. It is claimed that the arrangement not only enables the most perfect conditions of combustion to be automatically maintained as the temperature of the burner gradually rises, but is also effectual in compensating for the differing qualities of gas in different localities.

Several articles deal in a general manner with High Pressure Gas Lighting (Bremer, *Z.f.B.*, Sept. 30; *Am. Gaslight Jour.*, Sept. 20). The technicalities of Incandescent Mantle Manufacture, especially those of artificial silk, are treated in a long article by **Bohm** (*J.f.G.*, Sept. 25); see also article on same subject in the *Oester. Ungar Installateur*, July 24).

The very complete serial article in the *Zeitschrift für Beleuchtungswesen,* dealing with Automatic Ignition of Gas by pressure-raising devices is completed; the author now commences to describe electrical devices. A recent number of *The Progressive Age* also refers to the "Auto-Flame" burner (Sept. 15, *Prog. Age*), which is equipped with an igniting device apparently depending on a pyphoric principle.

Among articles on Oil Lighting mention may be made of the descriptive note in *The Illuminating Engineer* (New York), in which the Evolution of the Oil

LAMP is traced, chiefly from the æsthetic standpoint. The *Bursa* (Bucharest) contains an interesting note on the PURIFICATION OF PETROLEUM intended for lamps. Some kinds of oil tend to smoke and smell, and are not very suitable for illuminating purposes. This is found to be due to the presence of certain aromatic hydro-carbons which the ordinary process of refining does not remove; they can, however, be effectually got rid of by treatment with sulphur dioxide.

List of References:—

Papers read at the Third Annual Convention of the Illuminating Engineering Society.

(A list of this series of papers will be found on p. 747.)

ILLUMINATION.

Adams, H. Standardisation (Pres. Address at the Association of Engineers in Charge, London).
Cooper, W. D. Design of Illuminating Installations using Luminous Tubes (*Elec. World*, N.Y., Sept. 23).
Editorials. The Convention of the Illuminating Engineering Society—The Synthesis of White Light—Luminous Tubes—Luminosity and Temperature (*Elec. World*, N.Y., Sept. 23).
Progress in Lighting (*Electrician*, Oct. 15).
Lighting Experts (*Prog. Age*, Oct. 15).
Various Subjects (*Illum. Eng.*, N.Y., Oct.).
The Convention of the Illuminating Engineering Society (*Elec. Rev.*, N.Y., Oct. 9; *Elec. World*, Sept. 30).
The Hudson Fulton Celebration (*Elec. World*, N.Y., Sept. 30).
Gaster, L. Cantor Lectures on Illumination (Abstracts, *Electrician*, Oct. 15, 22; *Nature*, Oct. 21).
Ives, H. E. The Daylight Efficiency of Artificial Illuminants (*Illum. Eng.*, N.Y., Oct.).
Marston, G. Private Lighting of Streets in America (*Elec. Times*, Oct. 7).
MacBeth, N. The Illumination of a Dining Room (*Illum. Eng.*, N.Y., Oct.).
Nutting, P. G. Luminosity and Temperature (*Elec. World*, N.Y., Sep. 23).
Perkins, J. H. New Methods and Specifications for Street Lighting (*Elec. Rev.*, N.Y., Oct. 2).
Parent, E. R. Guides to Navigation near Belle Isle (*Canadian Engineer*, Sept. 3).
Wahle, A. Relation of the Architect to the Illuminating Engineer (*Illum. Eng*,, N.Y., Oct.).
Wohlauer, A. A. Spacing of Light Units (*Elec. World*, N.Y., Sept. 16).
London's Electric Light Standards (*Elec. Industries*, Sept. 1).
Artificial Light (*Irish Builder and Engineer*).
The Local Government Board and the Lighting of Finchley (*G. W.*, Oct. 16).
The American Illuminating Engineering Society Convention (*J. G. L.*, Oct. 19; see also *Am. Gaslight Jour.*, Oct. 4; *Elec. Rev.*, N.Y., Oct. 2, 9; *Elec. World*, N.Y., Sept. 30, Oct. 7).
The Hudson-Fulton Celebration (*Elec. Rev.*, N.Y., Oct. 2, 9; *Elec. World*, N.Y., Sept. 30).

PHOTOMETRY.

Editorial. The Standard of Light (*Elec. World*, N.Y., Sept. 23).
Hart, J. P. The Absolute Standard of Light (*Elec. Rev.*, Sept. 25).
Morris, Airey. The Photometry of Differently Coloured Lights (*Electrician*, Aug. 30).
Perrine, A. A. An Experimental Study of the Globe Photometer (*Elec. World*, M.Y., Sept. 13).
Presser, E. E. Neuere Fortschritte auf dem Gebiete der Selenphotometrie (Schweiz, *E. T. Z.*, Aug. 28).
Shaad, G. C. A Portable Photometer for measuring the Intensity of Street Lighting Sources (*Illum Eng.*, N.Y., Oct).
Weinbeer, E. W. Beitrag zur Photometrierung linearer Lichtquellen (*Z. f. B.*, Oct. 10).

ELECTRIC LIGHTING.

Chretien, H. Remarque sur une loi empirique de Consommation des Lampes à Incandescence à Filament Metallique (*Rev. Electrique*, Oct. 15).
Craig and Clayton. Flame Arc Lamps (*Illumination*, Sept.).
Editorials. Income from Tungsten Street Lighting Sources (*Elec. Rev.*, N.Y., Oct. 9).
British Elec. Lighting Acts (*Elec. World*, Oct. 7).
Henry. Vie Utile des Lampes à Filament Metallique (*L'Electricien*, Oct. 2).
Ives, H. E. White Light from the Mercury Arc and its Complementary (*Elec. World*, N.Y., Sept. 23)
Jolley, A. C. Modern Incandescent Electric Lamps (*Electrician*, Aug. 13, 20).
Prince, F. W. Low Voltage Tungsten Lamps in Residence Lighting (*Elec. World*, N.Y., Sept. 16).
Rosemeyer, J. Die "Conta" Lampe (Schweiz, *E. T. Z.*, Oct. 9).
Seager, J. A. Electric Illumination Topics in Great Britain (*Illum. Eng.*, N.Y., Oct.).
Wikander, E. Die Popularisierung der elektrischen Beleuchtung (*E. T. Z.*, Oct. 7).
Domestic Electrification (*Elec. Times* Special Number, Oct. 14).
Twelve Months' Progress in the Use of Metallic Filament Lamps for Street Lighting (*Electrician*, Oct. 15).
Beschlagfreie Flammenbogenlampen (*E. T. Z.*, Sept. 23).
Neue Glühlampenprüfer (*E. T. Z.*, Sept. 23).
Fortschritte auf dem Gebiete der Elektrotechnik.
1. Bogenlampen (*Elek. u. Masch.*, Oct. 3).
2. Glühlampen (*Elek. u. Masch.*, Oct. 10).

Neue Glühkörper (*Oesterr.-Ungar Installateur*, Oct. 2).
Annual Meeting of the Association of Car Lighting Engineers (*Elec. Rev.*, N.Y., Oct. 9).
The Welsbach Offer (*Electricity*, Oct. 1; *J. G. L.*, Sept. 28; *Elec. Times*, Sept. 30; *Elec. Industries*, Sept. 29, &c.).
Die Abhängigkeit des Wattverbrauches einer Metallfadenlampe von der Brennspannung (*Elek. Anz.*, Aug. 26).
Neue Flammenbogen-Armaturen (*Z. f. B.*, Oct. 10).
Eine neue Leuchtreklame (Oesterr.-Ungar. Installateur, Aug. 14).
The Jandus Regenerative Arc (*Elec. Times*, Sept. 30).
The Magical Electric Home (*Edison Monthly*, Sept.).
Electric House-Wiring (*Builder's Journal*, Sept. 29).
A New Electric Sign (*Elec. Times*, Oct. 7).
The Downward Tendency of the Candle-Power of Metallic Filament Lamps (*Elec. Times*, Oct. 7).
New Concrete Arc Lampposts in Chicago (*Elec. World*, N.Y., Sept. 16).
Tungsten Street Arches (*Elec. World*, N.Y., Sept. 16).

GAS, OIL, AND ACETYLENE LIGHTING, &c.

Böhm, Dr. C. R. Der Kunstseide Glühkörper (*J. f. G.*, Sept. 25).
Bremer, R. Pressgasbeleucting, continued (*Z. f. B.*, Sept. 30).
Bunte, H. What Quality of Gas is called for? (*J. G. L.*, Sept. 28).
Editorials. Incandescent Burners and Incandescent Electric Lamps (*G. W.*, Oct. 2).
The Best Gas......The "Metropolitan" No. 2 Burner (*J. G. L.*, Oct. 12).
Lebeis. The Development of Inverted Incandescent Gaslighting (*The Plumber*, Oct. 1).
Lynn, J. T. Presidential Address at Michigan Gas Association (*Prog. Age*, Oct. 1. 1909).
McBeth, N. Illuminating Engineering Problems with Gas (*Am. Gaslight Jour.*, Oct. 11).
Owens, H. T. Some Notes from Abroad (*Am. Gaslight Jour.*, Sept. 20).
Ross, J. H. Acetylene Lamps and Generators (*Acetylene*, Oct.).
High Pressure Gaslighting (*Am. Gaslight Jour.* Sept. 20).
Lighting Fixtures for 1909 (*Prog. Age*, Sept. 15).
New Street-lamp Designs (*J. G. L.*, Sept. 28).
A Chain Support for Gas Fixtures (*Prog. Age*, Sept. 15).
New Holophane Reflectors (*Prog. Age*, Sept. 15).
The Selas System of Lighting (*G. W.*, Oct. 2).
Automatic Air-regulation in Inverted Burners (*G. W.*, Oct. 2, 1909).
The Falcon Lamps and Burners (*G. W.*, Oct. 2).
Neue Glühstrümpfe (*Oesterr. -Ungar. Installateur*, July 24).
Un nouveau Bec Reversé (*Le Moniteur de l' Industrie du Gaz, &c.*, Sept. 30).
Gas-Zündvorrichtungen, continued, Druckstoss-gasfernzünder (*Z. f. B.*, Sept. 20); Elektrische Zünder (*Z. f. B.*, October 20).
The Auto-Flame Burner (*Prog. Age*, Sept. 15).
The Degea Outside Lamp (*J. G. L.*, Oct. 12).
Northern Lights (*Am. Gaslight Jour.*, Oct. 11).
Acetylene in Hawaii (*Acetylene Jour.*, Oct. 11).
The Development of the Oil Lamp (*Illum. Eng. N.Y.*, Oct).
Lampanturile Romànesti (*Bursa, Bucharest*, Oct. 3).

CONTRACTIONS USED.

E. T. Z.—*Elektrotechnische Zeitschrift.*
G. W.—*Gas World.*
Illum. Eng., N.Y.—*Illuminating Engineer of New York.*
J. G. L.—*Journal of Gaslighting.*
J. f. G.—*Journal für Gasbeleuchtung und Wasserversorgung.*
Prog. Age.—*Progressive Age.*
Phys. Rev.—*Physical Review.*
Z. f. B.—*Zeitschrift für Beleuchtungswesen.*

The New Fittings Showroom of Messrs. Siemens Bros., Ltd.

On Wednesday, October 27th, a number of representatives of the press had the opportunity of visiting the new fittings showroom of **Messrs. Siemens Bros., Ltd.**, at 39, Upper Thames Street E.C., which will be open from Nov. 1st, and where all the business of the supplies-department will in future be conducted.

All the specialities of the firm will be on exhibition, including the latest designs in electric light fittings and shades. A feature will be the presence on the premises of the special technical advisers of the firm to assist customers in their respective departments.

After inspection of the premises a lunch was served at Cannon Street Hotel, and the toast of the future prosperity of the firm was drunk by those present.

PATENT LIST.

COMPLETE SPECIFICATIONS ACCEPTED OR OPEN TO PUBLIC INSPECTION.

I.—ELECTRIC LIGHTING.

19,395/08. Arc lamps. Sept. 15, 1908. Accepted Sept. 22, 1909. H. J. J. Jaburg, jun., 111, Hatton Garden, London.

19,847. Preventing disintegration of incandescent lamp filaments (C.S.). I.C. Oct. 3, 1907, Germany. Accepted Sept. 29, 1909. Glühlampenwerk Anker G. m. b. H., 31, Basinghall Street, London.

20,915. Fastening the filaments of incandescent lamps (C.S.). Oct. 3, 1908. Accepted Oct. 13, 1909. T. McKenna, 31, Basinghall Street, London. (From Glühlampenwerk Anker G. m. b. H., Germany.)

26,145. Lighting arrangements for dressing-tables, mirrors, &c. Dec. 3, 1908. Accepted Sept. 22, 1909. E. M. Ashley, 6, Lord Street, Liverpool.

26,287. Incandescent lamps. Dec. 4, 1908. Accepted Sept. 22, 1909. The British Thomson-Houston Co., Ltd., 83, Cannon Street, London. (From Allgemeine Elektricitäts Ges., Germany).

27,303. Feeding-mechanism for arc lamps. Dec. 16, 1908. Accepted Oct. 13, 1909. C. E. G. Gilbert, Cantley, Chingford.

27,816. Tilting shade-holders or carriers for electric lamps. Dec. 22, 1908. Accepted Oct. 6, 1909. M. Lawton and H. Whateson, 24, Temple Row, Birmingham.

432/09. Holders for incandescent lamps. Jan. 7, 1909. Accepted Oct. 13, 1909. F. W. Suter, Chancery Lane Station Chambers, London.

1,706. Vapour electric apparatus (C.S.). Jan. 23, 1909. Accepted Oct. 20, 1909. L. A. Audibert, 40, Chancery Lane, London.

3,637. Converting ordinary lamp-holders into switch lamp-holders (C.S.). Feb. 15, 1909. Accepted Sept. 22, 1909. E. B. Wright, 90, Station Road, Westcliff-on-Sea, Southend.

11,578. Arc Lamp (C.S.). I.C. Sept. 22, 1908, Germany. B. Duschnitz, 77, Colmore Row, Birmingham.

13,661. Suspension devices for supplying current to arc lamps (C.S.). June 10, 1909. Accepted Sept. 29, 1909. A. Schweiger, 345, St. John Street, London.

15,532. Stage arc lamps (C.S.). July 3, 1909. Accepted Oct. 20, 1909. A. Walters, 4, St. Ann's Square, Manchester.

17,448. Arc lamps (C.S.). I.C. Nov. 9, 1908, Germany. Accept Oct. 20, 1909. T. L. Carboned Chancery Lane Station Chambers, London.

18,328. Flame arc lamps (C.S.). I.C. Aug. 11, 1908, Germany. Accepted Oct. 20, 1909. Siemens Schuckertwerke G. m. b. H., Birkbeck Bank Chambers, London.

21,374. Electrodes for arc lamps (C.S.). I.C. Oct. 5, 1908, Germany. Gebruder Siemens & Co. Birkbeck Bank Chambers, London.

22,302. Working arc lamps in series with incandescent lamps (C.S.). I.C. October 1, 1908, Germany. A. Heimann and W. Schäffer, 111, Hatton Garden, London.

II.—GAS LIGHTING.

20,667/08. Inverted regenerative gas lamps. Oct. 1, 1908. Accepted Oct. 13, 1909. R. J. Liebisch and C. Wooley, 55, Market Street, Manchester.

21,185. Controlling lights from a distance (C.S.). Oct. 7, 1908. Accepted Oct. 13, 1909. J. M. Tourtel and W. R. Mealing, 33, Cannon Street. London.

21,667. Incandescent lamps (C.S.). I.C. Oct. 16, 1907. Germany. Accepted Oct. 13, 1909. A. Martini, 31, Bedford Street, Strand.

21,669. Incandescent burners. Oct. 13, 1908. Accepted Oct. 20, 1909. J. M. Lecomte and M. Roy, 7, Southampton Buildings, London.

25,650. Controlling gas jets on railway vehicles, &c. (C.S.). Nov. 27, 1908. Accepted Oct. 13, 1909. G. H. d'Ivernois, 70, Chancery Lane, London.

27,522. Supports for incandescent burners. Dec. 18, 1908. Accepted Oct. 6, 1909. F. W. Jeffery, 17, Hanover Street. Keighley.

141/09. Supporting inverted incandescent mantles. Jan. 4, 1909. Accepted Oct. 13, 1809. W. Beale, 128, Colmore Row, Birmingham.

2,199. Incandescent burners (C.S.) Jan. 29, 1909. Accepted Oct. 13, 1909. L. Zeichnall, 70, Chancery Lane, London.

3,171. Catalytic material for automation ignition (C.S.) I.C. March 5, 1908, France. Accepted Oct. 6, 1909. C. Lubeck, 70, Chancery Lane, London.

5,199. Pyrophoric igniting device (C.S.). March 3, 1909. Accepted Oct. 13, 1909. C. Schmitt, 1, Queen Victoria Street, London.

5,289. Inverted incandescent burners (C.S.). March 4, 1909. Accepted Sept. 22, 1909. C. C. Carpenter, 6, Bream's Buildings, London.

6,542. Incandescent burners (C.S.). March 18, 1909. Accepted Oct. 6, 1909. Welsbach Incandescent Gas Light Co., Ltd., and W. Ruler, 18, Southampton Buildings, London.

7,514. Attaching incandescent mantles to mantle rings (C.S.). I.C. June 27, 1908, Germany. Accepted Oct. 13, 1909. E. Skriwan, 1, Great James Street, Bedford Row, London. Addition to 6.963/09.

8,575. Gas pendants (C.S.). April 8, 1909. Accepted Oct. 13, 1909. H. W. Hanwell, 111, Hatton Garden, London.

8,855. 8,856. Controlling gas burners from a distance (C.S.). I.C. May 26 and April 16, 1908, Germany. Accepted Oct. 20, 1909. F. Rossbach-Rousset, Chancery Lane Station Chambers, London.

9,139. Incandescent burners (C.S.). I.C. March 6, 1909, Germany. Accepted Sept. 29, 1909. Ehrich & Graetz, 18, Southampton Buildings, London.

10,945. Inverted incandescent lamps (C.S.). I.C. Jan. 8, 1909, Germany. Accepted Sept. 22, 1909. Ehrich & Graetz, 18, Southampton Buildings, London.

12,314. Controlling burners from a distance (C.S.). I.C. May 27, 1908, Germany. Accepted Oct. 6, 1909. E. Renkewitz, Chancery Lane Station Chambers, London.

19,935. Automatic lighting and extinguishing devices (C.S.). I.C. Sept. 22, 1908, Germany. Ehrich & Graetz, 57, Lincoln's Inn Fields, London.

21,437. Lighting and extinguishing gas lamps from a distance (C.S.). I.C. Sept. 25, 1908, Australia. U. S. McNab and J. S. Link, 115, Cannon Street, London.

III.—MISCELLANEOUS

(including lighting by unspecified means, and inventions of general applicability).

10,708/08. Lamp shades and reflectors (C.S.). May 16, 1908, post dated Sept. 11, 1908. Accepted Sept. 22, 1909. O. A. Mygatt, 322, High Holborn, London.

20,610. Incandescence vapour lamps. Sept. 30, 1908. Accepted Oct. 6, 1909. Kitson Empire Lighting Co., Ltd., and R. H. Stephens, Birkbeck Bank Chambers, London.

22,748. Photometer. Oct. 27, 1908. Accepted Oct. 20, 1909. H. Chapman, Ryecroft Villas, Meersbrook Road, Sheffield.

5,512/09. Illuminated advertising devices (C.S.). March 8, 1909. Accepted Oct. 20, 1909. J. O. O'Brien, 6, Bank Street, Manchester (From Radium Light Reklame Co., G. m. b. H., Germany.)

19,838. Artificial lighting of halls used for kinematographic exhibitions or for photographic operations (C.S.). I.C. Sept. 14, 1908, France. E. Grenier, 47, Lincoln's Inn Fields, London.

EXPLANATORY NOTES.

(C.S.) Application accompanied by a Complete Specification.

(I.C.) Date applied for under the International Convention, being the date of application in the country mentioned.

Accepted.—Date of advertisement of acceptance.

N.B.—The titles are abbreviated. This list is not exhaustive, but comprises those Patents which appear to be most closely connected with illumination.

Some Publications Received during the past Month.*

Die Glasindustrie in Jena, ein werk von Schott und Abbe. By Dr. E. Zschimmer. (Published by E. Diederichs, Jena, Germany, 1909).—This well got up work, prepared by Dr. Zschimmer of Schott and Gen., Jena, describes in a popular manner the development of glass manufacture and the various achievements of this firm. A special feature of the book is the admirable artistic illustrations. We hope to deal with it more fully later.

Fortschritte der Strassenbeleuchtung. By Dr. L. Bloch (reprinted from the *Elektrotechnische Zeitschrift*, 1909).

Light and Sanitation. By Sir James Crichton-Browne, M.D. LL.D. F.R.S. (Sherratt & Hughes, 27, St. Ann Street, Manchester).—An address delivered at the Jubilee Conference of the Manchester and Salford Sanitary Association, 1902.

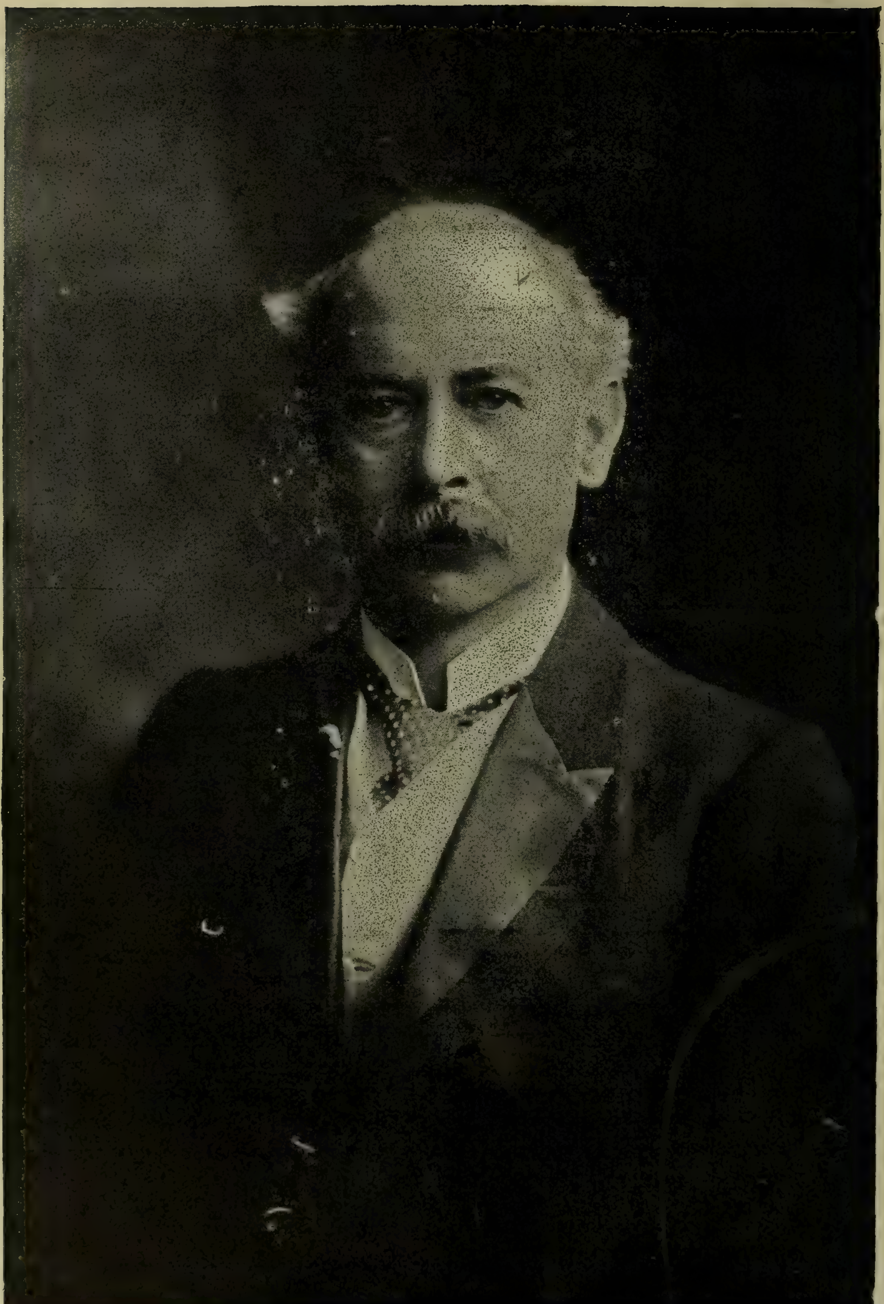
Die weitere Entwicklung der Metallfadenlampen auf Grund der Erfahrungen des letzten Jahres. By A. Libesney (paper read at the annual meeting of the Verband Deutscher Elektrotechniker, Cologne, 1909, reprinted from the *Elektrotechnische Zeitschrift*).

Das C. R. Gesetz und die Kabelschnelltelegraphie. By Bela Gati (reprinted from *Elektrotechnik und Maschinenbau*).

The Journal of the Municipal School of Technology, Manchester.—A well got-up record of investigations undertaken by members of the teaching staff of the departments of the school, Vol. I., part 3.

Among other publications received we have to acknowledge:—*Proceedings of the Am. Acad. of Arts and Sciences*, and of the *Am. Institution of Electrical Engineers*, *Annali della Soc. degli Ingegneri e degli Architetti Italiani*, *Journal of the Franklin Institute*, *Journal of the Institution of Electrical Engineers* (*London*), *Journal of the Society of Architects*, *Journal of the Western Society of Engineers*, *Physical Review*, &c.

* To some of these we hope to refer in greater detail on a future occasion.



Prof. S. P. THOMPSON, D.Sc., F.R.S.,

First President of the Illuminating Engineering Society (Founded in London, 1909).

The ILLUMINATING ENGINEER

ELECTRICITY · ACETYLENE · OIL · GAS

Edited by LEON GASTER

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EDITORIAL.

The Inaugural Meeting of The Illuminating Engineering Society.

ON pages 807-837 of this number our readers will find a full account of the Inaugural Meeting of the Illuminating Engineering Society, which was held at the Royal Society of Arts on November 18th. It is now mere repetition to say that the meeting was in every way successful, and that our First President delivered an address which was greeted with enthusiasm, and which will long be treasured as an exact description of the aims, objects, and aspirations of the Society.

In passing, however, we should like to draw special attention to the kind words of those who supported the vote of thanks to the President, and to point out that the professions of these speakers, Sir Boverton Redwood, Mr. A. P. Trotter, Mr. W. Mordey, Prof. Walmsley, and Dr. J. S. Haldane, very aptly illustrate the number of different interests to which the subject of illumination and the work of the Society are calculated to appeal. If we may select one of these admirable speeches for special reference, we should like to emphasise Dr. Haldane's words regarding the importance of the subject to the physiologist. We have always felt that the help of this expert was extremely essential in solving problems of lighting, and we heartily welcome Dr. Haldane's assurance that his profession will support the movement.

We have only to add that the audience was a very distinguished one, and representative of all the professions concerned with illuminating engineering.

In addition messages expressing good wishes for the welfare of the Society, and regret at unavoidable absence on this important occasion, were received from many distinguished quarters. We may take this opportunity of thanking all for their kind congratulations, and should like to add that if we have failed to acknowledge many kind messages, our omission has been due solely to the very large number of such communications received.

In particular we wish to express our appreciation of the many messages of encouragement received from our friends in America and on the Continent, and much regret that they were unable to be present with us at the inaugural meeting. We hope, however, that those who find themselves unable to be present at future gatherings will not lose sight of the possibility of communicating their views in writing previous to the meeting, and we shall endeavour in future to announce the subject of the coming meeting as early as possible, and to send advance proofs to distant members. Meantime we may remind our readers that the next meeting has been announced to take place on Jan. 11th, 1910, when a discussion on "Glare: its Causes and Effects," will be opened by Dr. J. H. Parsons, F.R.C.S.

Those who had not the privilege of hearing the presidential address on Nov. 18th, will have the next best thing—the opportunity of reading it in this number of our journal. Prof. Thompson pleads for the establishment of lighting on scientific basis instead of the rule of thumb methods which were considered sufficient in the past. Intimately bound up with this conception of scientific illumination is the study of the measurement of light.

Another point on which the President laid special stress, was the number of problems of common interest to all concerned with illumination, involving "the art of directing light" as apart from its production. It is here that the Society will find its first work.

The Inaugural Meeting has aroused considerable interest both in the daily and the technical press, and has been widely commented upon. Such comments, we are happy to observe have been almost invariably enthusiastic, a fact which speaks volumes for the educational work that has been done since the Society was first suggested.

We should, however, like to refer to some minor points raised by our contemporaries who have again referred in kind terms to our efforts, and expressed general sympathy with the aims and objects of the Society.

One contemporary, for example, expresses a desire, which we share, for a fuller representation of members connected with the gas industry. We need hardly say that from the very first we have tried to make it clear that the Society was open to all connected with, or interested in, the subject of illumination, in all its branches, and have taken special pains to attract members of the gas fraternity, many of whom we are already pleased to recognise as our staunch supporters.

We trust that our gas friends will make up their minds and take advantage of the free platform of the Society, and urge others to help in our endeavours, so that the balance of representation may be well secured.

The Lighting of Libraries.

This is a subject on which we have several times had something to say. About a year ago we drew attention to the valuable and exhaustive paper read at the Second Convention of the Illuminating Engineering Society by Mr. L. B. Marks, in which the lighting of the Carnegie Libraries in New York was fully described.

The illumination of a library, as this paper fully demonstrated, requires that attention should be devoted to a series of important details. It would probably be admitted that a moderate general illumination is necessary. In addition a good local illumination on the reading tables is, of course, essential, and it is also desirable that some provision should be made for the illumination of the volumes on the shelves, so that readers can readily pick out any book they desire. But above all the illumination, besides being sufficient, must possess no trace of glare. A tendency to glare which

might be pardonable in the ordinary interior is here quite inadmissable.

It is not enough to say that lights of great intrinsic brilliancy should not be placed close to the eye and in the direct range of sight. It is also desirable to render it impossible for a reader to see such a source of light out of the tail of his eye; everyone knows the inconvenience of trying to read under these conditions. And we need hardly add how vital it is that when table lights, placed quite close to the reader's head, are installed, their shading should be properly attended to.

These remarks are called forth by a consideration of some of the alterations that are taking place at the Patent Office Library in London. The old arrangement here was admittedly defective. The clusters of lights by which the main hall is illuminated were placed over the gangways, with the result that the illumination on the tables was frequently in many places insufficient.

It was, therefore, gratifying to notice that the authorities have determined to supplement the existing illumination by lamps fixed on the reading tables, and we observe that wires have already been brought up to standards thereon, and during the last few weeks experiments have been made with several types of shades. It appears, however, that ordinary opal glass shades, only partially covering the naked lamp-bulbs, have been installed.

It need hardly be said that such an arrangement is quite inadequate for the lighting of library-tables. The inconvenience to readers of being able see the naked filament at such short range hardly needs comment; glare at such close quarters is liable to be destructive of any peace of mind.

What is needed in fixtures of this description is a suitable concentrating shade which directs the light where it is wanted, and *completely* screens the source itself, so that the eye cannot possibly be offended by catching sight of a too brilliant surface. We hope, therefore, that in further experiments the authorities will bear this in mind, and sanction the small additional expense necessary to put matters on a proper footing.

The Study of Photometry.

A paper by F. K. Richtmyer, read at the Third Annual Convention of the Illuminating Engineering Society, New York, and dealing with the course of instruction in illuminating engineering organized by the author at Cornell University, U.S.A., will be found in this number (p. 851).

It is pointed out therein that the essence of successful illuminating engineering consists in measurement; this, as we remarked above, was admirably brought out in Prof. Silvanus P. Thompson's Presidential Address. It is therefore to be desired that students who are likely to come into touch with lighting problems should pay special attention to photometry, not so much with the object of becoming versed in all the subtleties of the subject, as with the object of getting a working knowledge of the measurement of illumination as a practical process. One weakness in the existing curricula of colleges in which the subject of photometry receives attention very frequently exists. As a rule the student carries out only a very few experiments on photometry and then passes to other matters, chiefly impressed with an idea of the complexity and lack of reliability of the process.

This arises partly from the fact that he has really not time to become familiar with photometrical measurements from a practical standpoint, and partly because he is usually expected to carry out experiments involving a fair order of accuracy, such as only an observer with some practice and knowledge would probably attain.

It is necessary to point out that there are very many cases in which a measuring instrument can render good

service by supplying a record of conditions of illumination, even though its accuracy be in doubt to 10 per cent. What is wanted, above all, is to make the measurement of illumination a practical and familiar process, just as the measurement of electric current or gas is already felt to be.

The Sale of Light.

A paper on 'The Present Aspect of Electric Lighting,' delivered by Messrs. Handcock and Dykes before the Institution of Electrical Engineers on November 25th, is abstracted on p. 853 in this number. We cannot enter into the many technical questions raised in this paper, but there is one statement of the authors, that in the future lighting stations will be driven to sell not electric energy but *light*, which is of considerable interest. This is a view with which we find ourselves in sympathy, though, of course, we recognize that such a development will probably only proceed very gradually.

At the present day we know that great improvements in this direction have been made, and Messrs. Handcock and Dykes are probably only voicing the thoughts of all careful students of present conditions in anticipating that the ultimate main duty of a gas or electrical company is to sell *light*.

At the same time it is necessary that those who endorse this policy should realize the conditions which it brings with it. Improvements in methods of generating light will only benefit the supply companies if they have a very clear conception of their duty to the consumer, and study the utilization of the light he purchases to the best advantage. The company that professes to sell light will have to be prepared in the future to consider also the conditions under which this light is to be used, and, if need be, to undertake measurements to reassure consumers that they are receiving the illumination that is their due.

As we have often pointed out in this connection, mere ocular demonstrations unsupported by precise scientific tests are unsatisfactory; it is not enough to say to the consumer, as the authors do, "Come and look at this room lit electrically," &c. You must be able to prove to him that the lighting is equal to that provided by any rival system, and at a subsequent date you must be able to ascertain for him, if need be, whether the illumination is well up to the mark, and prove to him that it is so should he have unjustified suspicions. This can be accomplished by proper scientific measurements, and in this way only.

According to the system adopted in the past the consumer has been, at any rate, in a position to appeal to his meter reading, even though these systems frequently led to misunderstandings and wrangles with the company, which we, in common with the authors, desire to see remedied. We are therefore only too glad to encourage any scheme of charging that promises to promote a good understanding between consumer and company. We, too, feel that companies will necessarily come to take a more direct interest in the conditions of illumination enjoyed by a consumer, and therefore to study illuminating engineering.

Such study must be based on adequate measurement. The problem, we admit, is somewhat complicated, as so many factors affect the successful lighting of an interior. But there is every reason to hope that as the desirability of such a system comes to be recognized, the correct course will gradually reveal itself, and the difficulties now so clearly perceived will be gradually smoothed away.

LEON GASTER.

Review of Contents of this Issue.

Mr. A. P. Trotter (p. 799) proceeds with his descriptions of VARIOUS TYPES OF ILLUMINOMETERS. In the present instalment he deals with the Third Pattern Trotter Illumination Photometer, as described at the discussion on Mr. H. Fowler's paper at the Institution of Mechanical Engineers in 1906. He also describes the Everett-Edgcumbe pattern of the Trotter Illumination-photometer, and the various adjustments, and shows a view of the scale of candle-power with which this instrument is equipped.

Dr. M. Gaster, in the present instalment, concludes his series of articles dealing with LIGHT IN CUSTOM AND SUPERSTITION (p. 804). He shows how the connexion established between light and divinity and immortality, which was traced in former articles, extended ultimately to mythical beliefs and superstitions. Thus the appearance of supernatural beings, demons, and ghosts has always been associated with luminous effects, and the very name given to the Prince of Evil, "Lucifer," is symbolic.

Pages 807–837 are devoted to the **Inaugural Meeting** of the **Illuminating Engineering Society** which took place on November 18th at the House of the Royal Society of Arts. On p. 807 will be found an account of the meeting and an abstract of the speeches of **Sir Boverton Redwood, Mr. A. P. Trotter, Mr. W. Mordey, Prof. Walmsley,** and **Dr. J. S. Haldane,** who supported a vote of thanks to the President for his address. All these speakers expressed their appreciation of the address delivered by the President, and spoke of the good work which the Society would be called upon to carry out. It may be added that the vocations of the various speakers aptly illustrate the different professions to which the subject of illumination and the aims of the society may be expected to appeal.

Following this account of the meeting will be found a selection of a few of the GOOD WISHES FOR THE WELFARE OF THE SOCIETY expressed by absent friends, and a list of some of the distinguished authorities, &c., who wrote expressing regret that indisposition or important previous engagements prevented their being present (p. 811).

On p. 825 will be found the official REPORT OF THE COUNCIL which was presented at the meeting. In this report a brief account is given of the steps leading to the formation of the Society, and of the aims and aspirations by which it will be guided in the future. Special attention is drawn to the fact that the main object of the Society is at present merely to provide an impartial platform where these problems connected with illumination may be discussed, and not to bestow titles or qualifications. Thus membership in the Illuminating Engineering Society does not entitle a member to describe himself as an illuminating engineer. Reference is also made to the international connection of the Society which, it is hoped, will be beneficial in time to come in enabling the Society to prosecute special researches and accumulate important information on points of detail.

On p. 829 will be found the COMPLETE LIST OF OFFICERS AND MEMBERS OF THE SOCIETY, the Vice-Presidents, Members of Council, and Corresponding Members being indicated in special type. The invitation card to this meeting, which will some day have a certain historic interest, is also reproduced.

Reference may next be made to the INAUGURAL ADDRESS of **Prof. S. P. Thompson, D.Sc. F.R.S.** which will be found, *in extenso*, on p. 813. The President commences his address by pointing out the need for the existence of such a Society, capable of studying not only the production but also the art

of directing and adapting light, and he defines in general terms the wide interests which are collected together under the generic term "Illuminating Engineering." He traces the strides which have been made in the progress of illumination within the last few generations and gives some account of the historical development of the art of lighting and the sciences of optics and photometry. In this connection he dwells specially on the need for measurement and for a common system of units relating to illumination, referring to the recent important international agreement on this question. In this connection the President shows how the Society might perform valuable work by being instrumental in forming Committees capable of dealing with specially important problems in illumination.

Thus, there is a need for much more knowledge regarding the reflecting powers of different materials, the intrinsic brilliancy of illuminants and the different physiological factors which are introduced into problems of illumination by the complexities of the eye. In the last portion of his address the President makes special reference to many practical matters, such as the lighting of schools, factories, and buildings of architectural distinction, regarding which much has yet to be learned, and in connexion with which the Society has also much useful work awaiting it.

Among other articles in this number reference may be made to that of **Mr. W. W. Coblentz** (p. 839), who discusses the several existing methods of studying Radiation Phenomena of Incandescent Surfaces and gives the results of some experiments on tungsten and carbon filaments. He publishes two curves showing the quality of radiation from these two filaments. The maxima occur at slightly different points in the spectrum, but the character of the curves are most distinct in the infra-red region.

A paper on Factory-lighting read by **Mr. L. B. Marks** at the Second Annual Convention of the Illuminating Engineering Society in the United States is dealt with on p. 845. The author summarises his experiences when examining the lighting of five different factories, and concludes with a series of general recommendations. Special insistence is placed on the avoidance of glare and direct reflection into the workers' eyes from shining metallic surfaces.

A lecture delivered by the Editor of this journal, **Mr. L. Gaster,** at the London Institution, is reproduced in abstract on p. 843. While dealing with Modern Methods of Illumination special reference is made to the need for a standard specification for illuminating apparatus, an analogy being drawn with the action of the Guild of Waxchandlers in the fourteenth century.

A paper by **F. K. Richtmyer** before the Second Annual Convention of the Illuminating Engineering Society in the United States will be found on p. 851. The author deals mainly with Courses of Instruction in Illuminating Engineering in technical colleges, and gives an account of a series of experiments in photometry organised at Cornell University.

Among other articles in this number attention may be drawn to the account of the paper by **Messrs. Handcock and Dykes** (p. 853), on The Present Aspect of Electric Lighting, in which the authors recommend a system of charging based on a fixed quarterly payment irrespective of the amount of electricity consumed.

An article on p. 802 refers to a recent paper by **Mr. J. S. Dow** on the Theory of the Flicker Photometer. In this paper the author gives a more complete account of the experiments described in an article in a previous number of this journal (Sept., 1909).

Attention may also be drawn to the contribution on p. 838 dealing with Some Effects of Ultra-Violet Light. Here some account is given of the experiments of certain authorities on the germicidal action of rays of this kind, and several apparently conflicting opinions on these points are quoted.

On pages 861 and 864 will be found the usual Review of the Technical Press and the Patent List.

TECHNICAL SECTION.

[*The Editor, while not soliciting contributions, is willing to consider the publication of original articles submitted to him, or letters intended for inclusion in the correspondence columns of 'The Illuminating Engineer.'*

The Editor does not necessarily identify himself with the opinions expressed by his contributors.]

Illumination, Its Distribution and Measurement.

By A. P. Trotter,

Electrical Adviser to the Board of Trade.

(*Continued from p.* 730.)

Third Pattern Trotter Illumination Photometer.—A few months before the reading of Mr. H. Fowler's paper I was asked to recommend an illumination-photometer, and no pattern of my design being on the market, and all the patents lapsed, I made a number of experiments with the view of improving on previous models. Several kinds of curved screens were tried with the view of extending the scale without further mechanism, but these were not satisfactory, and I returned to the use of a snail cam and chain, and made an instrument which I showed at the discussion on Mr. H. Fowler's paper* at the Institution of Mechanical Engineers.

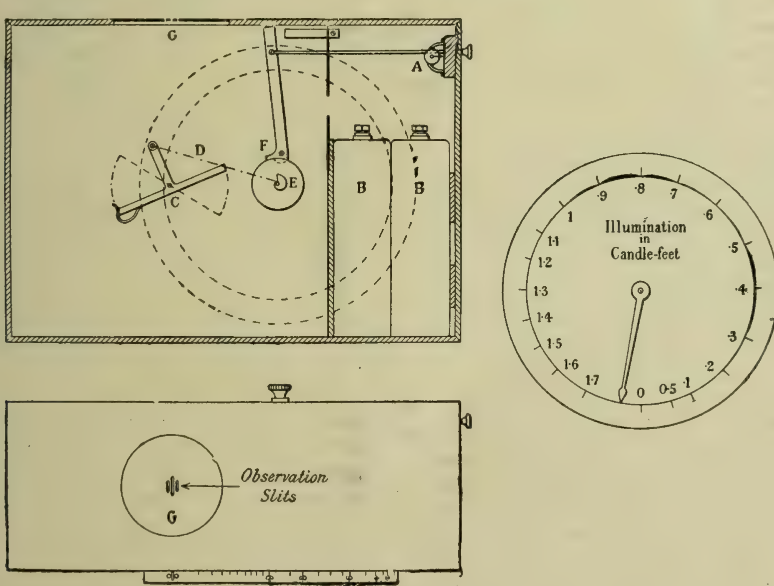

Fig. 96.

This pattern is illustrated in Fig. 96. The lamp with a single straight filament is seen end on at A. It was supplied by the accumulators B B. The light passed through a slit in a

* Proc. Inst. Mech. Engineers, 1906, p. 991. This illustration is reproduced by permission of the Council of the Institution.

partition thus cutting off stray light. The movable screen C was pulled counter-clockwise by a long thin spiral spring not shown in the illustration, and was pulled clockwise by the fine aneroid chain D, which was wound up on the little snail cam E. A pointer moving on a graduated dial was fixed to the spindle carrying the cam. The illumination to be measured was received on the screen G. Three narrow slits were cut in this, and the screen C was seen through them. The cam E was turned until the middle slit was as little visible as possible. As soon as the best balance was obtained, the lamp was switched off, and by the certainty that the ground surface will occupy the same plane. It is necessary to prevent light from striking the edge of the glass when it is nearly in the grazing position. Regarding warping as a slight displacement of the screen, Mr. Millar's warning that this will produce a marked difference at low illuminations is well justified.

Everett, Egdcumbe's Pattern of Trotter Illumination Photometer.—I did not use the photometer illustrated in Fig. 96, but handed it to Messrs. Everett, Edgcumbe & Co. They have made a considerable number of instruments and have introduced several modifications, some of them being marked

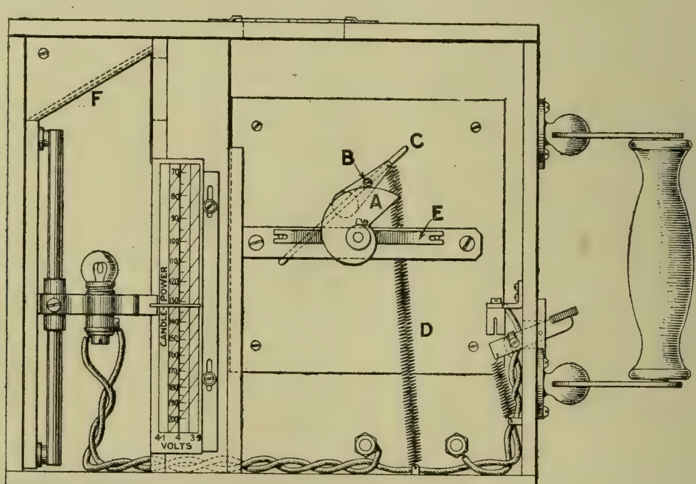

Fig. 97.

same movement, a clamp F held the spindle and pointer in position. This was necessary because the spindle was very free to move. The perforated screen was of Bristol board, the glaze having been removed with a damp cloth. The movable screen was of fine ground glass, held up against the rebate of a metal frame by a spring at the back. The dull surface was the one seen, the other side was painted with oil paint. This makes an excellent screen, for it is flat and cannot warp. It is easily cleaned, and can be tinted any colour. The method of fixing it is independent of the thickness. Another screen may be substituted with the improvements on my model. Fig. 97 shows one of their earlier patterns. The snail cam A is retained, much enlarged, and therefore more accurately shaped. Instead of the chain, a little roller B attached to the movable screen C bears directly on the edge of the cam, pressed against it by the long spiral spring D. A light leaf spring E is provided, which while giving just enough friction to hold the screen in any position allows a very free motion. Owing to the workmanship and the design, the motion of the mechanism is superior to any of my previous instruments. The cam is shaped so that the scale (Fig. 98) is almost evenly divided

over about 300 to 320 degrees on the dial, but is more open at the lower end so that feeble illuminations can be accurately measured.

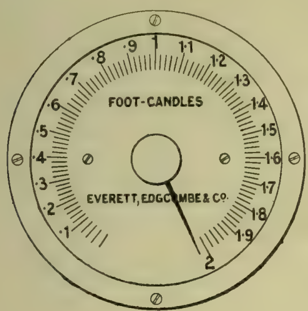

FIG. 98.

Two modifications introduced by Messrs. Everett, Edgcumbe & Co. are departures from my previous designs. The light from the lamp does not fall direct on the movable screen as in all the other patterns, but passes upwards to a mirror, F, and is reflected to the screen. This saves space and gives facility for an ingenious adjustment of the lamp.

Direction of View.—The other departure is the direction of view of the observer. I always observed the perforated screen from a point immediately above it. It is necessary to fix some point or rather direction of view, and I chose the vertical one partly because the spot below a lamp is often occupied by a lamp post or is in shadow, and partly because with an inverted lamp the illumination in the neighbourhood of the point on the ground immediately below it does not vary much.

A single slot is generally used, for with the greater distance of the lamp made possible by the mirror, the difference between the brilliance of triple slots is not enough to be useful. The screen is viewed at an angle of about 20 degrees with the vertical. When the eye is in the right plane the knob by which the pointer is turned is in a line with the slot in the screen. The movable screen is mounted in a frame and two small black pointers are fixed at the axis on which it rotates. When the eye is in the right plane one or other of these pointers may be seen through the slot if the observer's head is moved a little to one side or the other. Fig. 99 shows a movable screen and pointers D, the slot in the perforated screen is shown by dotted lines.

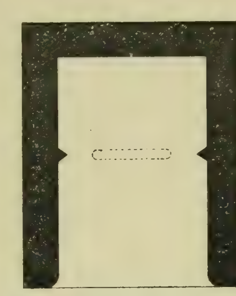

FIG 99.

The chief reason for abandoning the perpendicular direction of view was the proposal by the makers to use the photometer for measuring candle-power as well as illumination, and having adapted it for that purpose,

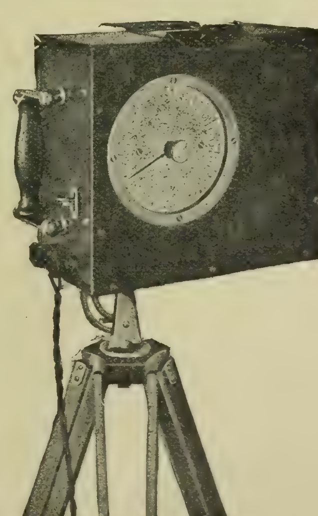

FIG. 100.

they gave it the name "universal." The perforated screen is set directly facing the lamp, when candle-power is to be measured, thus simplifying the calculation; and folding shutters or "blinkers" are provided to screen off

other lights. To set the screen in this position, the photometer is mounted on a tripod with a pivotted and hinged head, enabling the instrument to be turned in any direction and fixed at any angle. Since the screen faces the light, the direction of view must be other than perpendicular to it, and an angle of 20 degrees has been chosen.

Adjustment of the Lamp.—The lamp is clamped to a pillar. In some cases two lamps and two pillars are used to give a greater range. In order to give facility for handling them they are then attached to the lid and not to the box. The lamp carries an index which points to a scale of candle-power. When the lamp occupies a position corresponding to its own candle-power, the instrument is direct reading in foot-candles.

Provision is made on the scale for allowing for slight variation of voltage. But this is of doubtful value, for any good two-cell accumulator discharged for a short time before using will give four volts with great constancy. If the lamp is switched on only while a reading is being taken (and 15 seconds is ample for this) the total discharge during an evening's work will not amount to more than 20 or 25 minutes. If at any time a new lamp is fitted, the instrument should be carefully checked with a good sub-standard of light of, say, J candle-power at a distance, say, d feet, the lamp being set directly facing the perforated screen. After obtaining a photometric balance the reading on the scale should be J/d^2. If, however, instead of this, the dial reading should be, say, 5 per cent too high, the lamp inside the photometer should be moved upwards (that is, nearer the mirror) by 5 per cent.

(*To be continued.*)

The Flicker Photometer, and the Physiological Theories of the Retina.

In the September number of this journal an article was published by Mr. J. S. Dow, dealing with the theory of the flicker photometer; in this an attempt was made to account for the difference in the behaviour of instruments of this class and those depending on the equality of brightness principle, which becomes apparent when lights which differ in colour are compared (*Illum. Eng.*, Lond., Sept., 1909, p. 610).

A paper by the same author, in which this subject was discussed in greater detail, was read before the Physical Society on November 12th. In order to illustrate the characteristic difference in the behaviour of the two types of instruments, Mr. Dow presented some diagrams showing that the "yellow spot" and "Purkinje effects" were less marked in the case of the flicker photometer. An experiment was also shown in which two discs, having respectively red and black, and green and black sectors, were set in rotation. At a very low illumination it was observed that in the latter case a violent flicker could be seen by averted gaze, but disappeared when the eyes was directed straight towards the disc. In the case of the disc with red and black sectors exactly the opposite was the case. Mr. Dow explained that this seemed to fall in with the Rod and Cone theory, and apparently exhibited the difference in the conditions under which flicker was seen by these two sets of organs.

After briefly summarising his conclusions, Mr. Dow remarked that the theories of the retinal organs were the subject of much dispute between physiologists, and therefore it was very desirable that photometrical matters should be investigated by the Physiological profession.

The discussion was opened by Dr. F. W. Edridge Green, who said that he did not dispute the facts referred to by Mr. Dow, but that the theory of the rods and cones, as set forth in this paper, was not substantiated by the most recent researches in physiological optics. He himself had recently found

that visual purple, did exist in the fovea, and he thought that many of the physiological effects ascribed to a "struggle between the rods and cones" could be explained by the distribution of visual purple over the retina. According to his view the rods were concerned merely in the distribution of visual purple, &c., and did not play a direct part in vision at all; vision was accomplished through the cones, stimulated by the visual purple.

Some further discussion followed in which Mr. Alex Russell, Mr. C. C. Paterson, and Mr. A. P. Trotter took part. Mr. Alex. Russell asked how it was possible for the rods to be most sensitive to blue-green light and yet not to analyse it. Mr. Trotter recommended the use of a wider field of view and the blocking out of the central region of the retina, in order to study more exactly what happened in the peripheral regions.

In reply Mr. Dow said that Dr. Edridge Green's remarks aptly illustrated his insistence on the need for photometrical matters being studied by physiologists, who were naturally *au fait* with the most recent theories of retinal action. He quite realised that the mysteries of the retina were for the physiologists to settle, and, though he had not yet considered how Dr. Edridge Green's views could be fitted in with the usual phenomena of colour-photometry, he was very glad indeed to have had an opportunity of hearing them. The rod and cone theory had been utilized by certain photometrical experts to explain these effects, and it seemed to account for them very well. Apparently, however, physiological evidence was now against it.

Subsequently Mr. Dow dealt with several other queries raised, and said he approved of Mr. Trotter's suggestion for experimental purposes, though, of course, in a photometer one did not wish to depart too far from natural conditions; this was the objection to a suggestion of M. Blondel that we should confine ourselves to the central part of the retina where only cones were believed to exist.

(For further particulars of Dr. Edridge Green's interesting discovery of visual purple in the fovea, readers are referred to our last number, November, 1909, p. 741, and our March number, p. 210. Dr. Edridge Green also kindly sends us a copy of a letter from Prof. A. von Tschermak, of Vienna University, which was published in a recent number of *The Lancet*, and which lays stress on the importance of the changes in the condition of the retina corresponding with various stages in light- and dark-adaptation. It also remarks that the Purkinje effect, the colourless interval for spectral lights of increasing intensity, the different phases of the after-image, and other peculiar colour-effects, exist both in the centre of the retina and in the perpheral region, though gradually diminishing as we approach the centre of the eye. In other words, the difference is *quantitative* but not qualitative.)

A Suggested Method of Improving the Spectrum of the Mercury Lamp.

A RECENT number of the *Oesterr.-Ungar. Installateur* (July 3rd, 1909), refers to an interesting suggestion for improving the colour of the light from the mercury lamp.

Neon, it is stated, in a rarified condition, is known to be capable of giving out a brilliantly luminous spectrum, and this spectrum is approximately complementary to that of mercury vapour. It is, therefore, suggested that tubes of luminescing Neon might be placed adjacent to those containing mercury-vapour so that a good white light might be obtained by the combination. Another possibility is to enclose the Neon in the mercury tube itself, and experiments have been made with the object of determining the exact amount of the substance which is desirable in order to contribute the needful red rays.

Light in Custom and Superstition.

By Dr. M. Gaster.

(*Continued from p.* 733.)

As soon as we get upon a downward grade the descent gathers moment with the incline upon which we travel, and the depth to which we descend. Thus it happened with the downward movement of the light in the human worship. We are now approaching the last phase of that transformation. We are practically no longer dwelling with the light among the living but descend to the inferior regions and endeavour to follow the rays of the retreating light and to grope among the darkness at the distant light seen at the extreme end. It is the region of the fallen angels who, in accordance with their nature now use the fire as a destructive agent. There is only gloom, and it is left to the survivors in this world to provide for the departed the failing light, and on one day of the year to specially prepare for the departed a festive day of light. When the living can not reach the dead directly, not knowing whether they will be allowed to re-enter this world, they send a message of love in the shape of lighted eggshells down the stream of life to reach them at the extreme border where eternity begins and the departed dwell.

Soon, however, another interpretation was placed upon the practice of sending off these retreating little lighted ships. From a pious practice for the benefit of the dead, it became an "oracle" for the living, the symbol for a long life or one quickly cut off. For human life was likened to the lighted lamp, and death symbolised by the extinguished torch. These little lamps were then identified with the individual life, and they were looked upon as the life-tokens of those who kindled them and sent them on that curious errand. One cannot gainsay the poetical beauty of this conception, which sees and recognizes in those little frail craft the counterpart of human life floating down the stream of time and which therefore can be used to ascertain the length of the space of time allotted to him or her who lit such a lamp and sent it floating down the stream of water. If it kept burning bright so long as he could pursue it, it betokened long life, not quickly extinguished, but if, on the contrary, such a light sent off on a certain propitious and sacred day, did not burn long enough, and became extinct whilst he was still watching it, his doom was sealed. Thus the time which such a lamp was burning became an "oracle" to the Hindu, who sends it down the Ganges, and to many other nations who use their running waters.

But the people were not living everywhere close to streams and rivers, and therefore they had to be contented in many countries to watch the burning of the light kindled on the eve of New Year or St. John's Day, or some other day specially selected for that purpose, and to learn from the candles whether those who lit them would live for another year, or whether their light would be extinguished before the end of that year. The sudden extinction of a candle on the table strikes now also terror in the heart of people in many modern houses. True, they cannot account for the shock they experience, but it is the latest survival of that ancient set of ideas and beliefs. The symbolism of old, has now become a "superstition." There is no reasonable justification for that fear, and instead of the burning light being treated as a poetical symbol of life, resting on the belief in the divinity of light and its identity with the soul, it has become a meaningless and yet

dreaded superstition. Instinctively it is felt that darkness is the enemy of progress and of life and sudden darkness forebodes sudden danger.

There are then men and peoples who have turned away from the source of light, who live in constant dread and fear and who believe in propitiating the power that rules the darkness who keeps the dead as his possession and rules the world below. In most of the magical operations in which the infernal gods were invoked we find, therefore, one light after another being extinguished during the operation and that only after the last had been blown out the spirit appeared often in a luminous form. Some stress must be laid on this peculiar aspect of spirits, demons, ghosts, &c. The "fiery dragon" is often the name given to the power of evil. Was not his name also Lucifer, the "light bearer," who, though he had fallen from above in consequence of his rebellion, had retained the name and some of the attributes of light and fire. Many a demon, then, although as a rule described as black, still borrows light in order to lure men on to desolate spots or to dangerous bogs in the shape of dancing flames. The Will-o'-the Whisp is one of those demons which haunts the moors and holds up a false light to the unwary traveller who is unconscious of the danger into which it leads him. The graves of certain persons are also lit up by such appearances, the souls of sinners who cannot find rest in the grave, flit to and fro, and haunt the places of their former abode or of their former crimes. So the ghost is the shadow of its former luminous glory which is associated with the brilliancy of the soul, for it is spiritualized and has an ethereal shape, some of the old light has not yet been extinguished. Similarly, in the performances of the necromancer of old, who brought the dead up from the grave for his magical purposes, or in modern "seances" of the spiritists, exactly the same form of appearance is ascribed to the soul of the departed. In the light of our investigation it will not be difficult to trace the origin of this idea that the spirit of the departed must be in the likeness of a luminous cloud. Neither from the physiological nor from the metaphysical point of view is there the slightest justification for such an assumption. It is merely a remnant of the old world beliefs in, and of the old world worship of, *Light* as the source and symbol of life.

It is not possible to follow here this question further up or to discuss it at greater length. Suffice to have raised the problem of the "luminous" appearances of spirits and to have shown herein also a survival of such beliefs which belong to a past phase of human civilisation. Many a castle is known to be haunted by such luminous apparitions, almost in every case connected with some tragical event in the life of the deceased. The popular belief knows of "luminous" spirits or demons hovering over the place where treasure is buried. Many a peasant in Central and Eastern Europe has risked his life in the quest of such treasures indicated by the light over it. That treasure may have been concealed there by the person which after death is still guarding it against outsiders, or it was the outcome of some evil deed and the soul of the perpetrator of that wicked deed has no rest until the treasure is restored to its rightful owner. Or, as the case may be, it is a decoy of the evil one to lure some soul to perdition. And the "light" is used for a nefarious and evil purpose.

The most paradoxical thing, however, connected with light is the endeavour to use candles prepared in a special manner to conceal light, which should make the bearer of that light invisible, though he might be able to use it for his own purposes, and see by it. It is the thieves' candle, made of the most gruesome ingredients, among them human fat, or the finger of the left hand of an executed criminal used as a candle. To such depth has the light descended and to such uses has it been put, since it became associated with the evil power. The good can also be turned to evil. It depends upon the use which we make of the forces placed in our hands: we can use them for good purposes ensuring

thereby the happiness of man, or we may use them the wrong way, and instead of worshipping god we worship the evil one with the very same means which were destined for the nobler worship. The torch which is to light up our path in the onward march of knowledge and truth can be used for incendiary purposes, for destruction and ruin.

But out of evil cometh good also. In those ancient grand speculations about the end of things, the fire plays a decisive role. It has been worshipped as the great purifier of all the dross of material decaying nature ; it will come to its own at the end of time, when it will purify the world and cleanse it from all wickedness at the day of doom. A great fire will sweep the earth when the Day of Judgment is approaching and everything that is polluted in this world, will be licked up by those fiery tongues. All the ancient mythologies, notably that of the northern nation as well as the Oriental apocalyptic writers, usher in the kingdom of heaven upon earth by a wholesale purification through a general conflagration. Less radical and more in accord with the aspirations of mankind and the onward march of civilization, is the system of the gnostical schools. They tried to explain the eternal conflict between the good and the evil, between matter and spirit, and to hold out the hope of salvation to mankind on a different plan. They tell us that at the time of creation the evil spirit, *i.e.*, matter, got access to the treasury of divine light, and swallowed up the numberless sparks of light which God had scattered in the universe. Thus it came to pass that each spark was surrounded by matter in the form of created beings, and matter, which by its very nature is dark, is anxious to retain the possession of those divine sparks and to prevent them from returning to their divine origin. Hence the duty of every man, to fight matter and to liberate the spirit from the embrace of the gross material covering, which is represented by the body, and to free them one by one until the scattered sparks of divine light are reunited so as to form one luminous unity with their divine creator. Stripped of the poetical and mythological garb, the meaning of the simile is that the divine in us, the light from above, must be freed from the darkness of matter which is an obstacle to the salvation of man and an impediment to the progress of the world ; that it is the duty of man to reunite the divine sparks, by spreading knowledge and rolling back the clouds of darkness and ignorance, and thus to prepare the real kingdom of light and life. I could not finish this series of articles on "Light" better than by this old gnostic simile, which fits so well in with the aspirations and the work of *The Illuminating Engineer*, destined also to gather the scattered sparks of light and knowledge and to prepare a period of scientific "illumination."

The Iron and Steel Institute.

ANDREW CARNEGIE RESEARCH SCHOLARSHIP.

We have received from the Iron and Steel Institute particulars of the Research Scholarship founded by Mr. Andrew Carnegie, which is awarded annually, irrespective of sex or nationality, on the recommendation of the Council of the Institute, to suitable candidates under 35 years of age.

The object of the scholarship is to encourage the prosecution of researches in the metallurgy of iron and steel and allied subjects, the results of such researches being subsequently communicated in the form of a paper to the Iron and Steel Institute.

Further particulars may be obtained from the Secretary, Mr. G. C. Lloyd, 28, Victoria Street, London, S.W.

Illuminating Engineering Society.

(Founded in London, 1909.)

INAUGURAL MEETING.

Held at the Royal Society of Arts (London), on November 18th, 1909.

THE inaugural meeting of the Illuminating Engineering Society was held, by kind permission, at the house of the Royal Society of Arts, London, on Thursday, November 18th, a distinguished audience of about 150 being present.

In opening the proceedings, the **First President, Prof. S. P. Thompson, D.Sc., F.R.S.,** called on the Hon. Secretary, Mr. L. Gaster, to read a congratulatory cable received from the Society of the United States, letters from absent friends, and the Report of the Council.

Mr. L. Gaster said there was no reason why he should keep them long ; every one must be anxious to hear the President's address. It was his first duty to read the official cable expressing the good wishes of their friends in the United States. The message received from Mr. P. S. Millar, the General Secretary of the Illuminating Engineering Society in the United States was as follows :—

> "Council extends congratulations best wishes to Illuminating Engineering Society occasion first meeting."

He was sure all present would appreciate this mark of sympathy from their American friends, and would look forward to concerted and beneficial action on the part of the two Societies.

Mr. Gaster then proceeded to read extracts from a few letters received from supporters of the Society ; a few of these we have reproduced at the conclusion of this account on p. 811, together with a list of some of those who were unavoidably detained, but wrote expressing regret at their inability to be present.

Mr. Gaster subsequently read in abstract the Report of the Council (which was printed in full and distributed among those present), dwelling chiefly on the aims and objects of the Society as outlined therein.

The President then delivered his address, which was received with enthusiasm. This address is now reproduced in full on p. 813 of this number.

Sir Boverton Redwood, in proposing a vote of thanks to the President, said that it had been his good fortune to listen in this room to many addresses of a more than usually able character on former occasions, but he had never heard any address more ably or thoughtfully rendered, and of such entrancing interest, as that which had been so admirably delivered by Professor S. P. Thompson. Having heard that address, no one, he felt sure, could have any doubt as to the need for such a Society as that of which this was the inaugural meeting.

He sympathised with those, to whom reference had been made by the president, who objected to unnecessary multiplication of Societies. But here was obviously a case in which another society (whose need arose through the fact none of the older organizations had exhibited any disposition or capacity to deal effectually with this question of specialization) was admittedly necessary to study the question of proper illumination ; such specialization necessarily brought in its train the creation of special institutions or societies where this special subject could be discussed among sympathizers to their mutual satisfaction and encouragement.

At the present time, he imagined that we were very much in the position of a man who has suddenly come into great wealth. We were not able effectively to employ to the utmost limit of our knowledge the light at our disposal.

We had now various systems of brilliant illumination, which he feared were too often recklessly employed without due consideration for the functions proper illumination should discharge.

He had thought it might certainly be said that one of the most important functions of this Society would be to see that measures were adopted to minimise, as far as possible, the effect of brilliant illumination on the human eye. New methods of lighting, new and brighter illuminants, were springing up ; yet the eye, by the aid of which their light was perceived, was still the same. He was, therefore, very glad to hear from the President that the subject of "Glare" was to receive early attention from the Society.

He wished to take this opportunity of expressing his very high appreciation of the valuable work which had been done by his old friend Mr. L. Gaster. Without his active work, without that persevering industry which he always exhibited, he did not think that this Society would hold the strong position it did to-day, though its necessity was such that its coming was only a matter of time.

Those who had the privilege of knowing Professor Sylvanus Thompson would, no doubt, appreciate his acceptance of the position of President ; no better choice could have been made. He felt sure that every other person in the room there that night, who had heard the address, shared that view. Accordingly, he was sure that he was voicing the sentiment of every one present, when he submitted the motion "that the thanks of this Society are due to the President for his most interesting and instructive address and his consent is requested for this paper to be printed in the official organ of the Society."

Mr. A. P. Trotter said it gave him great pleasure to second the motion which Sir Boverton Redwood had so ably proposed. Those who knew the President must have come to the meeting well prepared for a model address and those who had not previously heard him must, he thought, have been perhaps almost more gratified than those who know him so well. It was not only a model address, delivered in a model manner, but was a model of scientific precision. He had set an example to be followed in subsequent meetings. The figures on the board would be a guide. We wanted to know more about the units and nomenclature, but there was one thing that struck him by its absence from the blackboard—the symbol "4π." And he had given a very good answer to the question "What is the good of the Illuminating Engineering Society ?" His answer took the form of another question, or rather a series of questions, asking "Does any one know?" which alone would provide several years' work for the Society to settle.

There were engineers and architects and scientific photometrists who were lamentably ignorant of the physiological factors of proper and efficient illumination and of photometry, but he hoped that not only our authorities but other scientific men would help towards the elucidation of these problems.

Lambert wrote "the eye is the only judge." What we have to do is not to satisfy an abstract theory, but the eye of the public.

Professor Thompson had made kind reference to his own work in the measurement of illumination, but he wished to draw special attention to the work of one who was unfortunately unable to be present at this meeting, Sir Wm. Preece, who was the first man, in 1883, to emphasize the need for the measurement of *illumination* as distinct from candle-power, in the lighting of streets. He said, then, that what we had to do was to measure the illumination in our streets, and he was the first man to invent and produce an illumination-photometer and to put it to practical use. And now the object of this Society was to deal with the development of efficient illumination and suitable apparatus.

He had the greatest pleasure, therefore, in seconding the motion.

Mr. W. Mordey (Past President of the Institution of Electrical Engineers) said he had much pleasure in supporting the motion and in expressing his appreciation of the lucid and instructive address of Professor Thompson. The Illuminating Engineering Society could not have had a better President nor one with wider interests. In addition to being a Past-President of the Institution of Electrical Engineers, he had been the founder of the Optical Society, and president of the Physical and Röntgen Societies. The President was equally distinguished in the arts, music, and languages, and he had a recollection of a friend of his who sat for an examination in playing the organ and returned to tell his friends that he was examined by Professor S. P. Thompson !

He recalled, too, how, on one of the annual foreign visits of the Institution of Electrical Engineers, Professor Thompson had explained that he could not proceed on the journey with the others, as he must be in Italy in a fortnight, and he wanted that fortnight to learn Italian. He did so, and subsequently delivered a series of speeches in that language. He felt, therefore, that the future of the Illuminating Engineering Society was in good hands.

And lastly he wished to congratulate Mr. Gaster on this successful result of his long and arduous labours ; after the enthusiasm and perseverance with which he had worked for this end, it must be gratifying to him, indeed, to see the formation of such a Society.

He had much pleasure in supporting the motion.

Prof. Walmsley, Principal of the Northampton Institute, said it was his duty to say a few words. Mr. Mordey had enumerated the president's qualifications for the office so fully and exhaustively that he had left very little for him to say in this respect. Nor need he repeat his appreciation of the brilliant oration to which they had just listened.

So rich was Professor Thompson's address in suggestions for the future, so full of scientific interest in its dealings with the past, that he felt it provided a worthy commencement for the career of the Society, and a most promising suggestion as to its future.

He must confess that when he first heard that there was to be a new scientific society he had a shiver of dismay, and, for a little time, he was somewhat sceptical ; but he had now no trace of scepticism as to the necessity for this society nor as to the useful career which lay before it, if it were only carried out in the spirit and with the zeal which was manifested in this address. Had he the slightest doubt, it would have vanished into thin air before the President even got through his explanation of the objects of the Society. The address also covered a wide range of matters both physiological and technical, and illustrated the variety of subjects with which the Society would have to deal.

He cordially supported the motion, and knew there could not be a single dissentient present.

Dr. J. S. Haldane remarked that the President had reminded them that the questions of illumination were to a large extent physiological questions. It was as a physiologist rather than as one of the Metropolitan Gas Referees that he rose to add one word in support of the motion of thanks to the President for the admirable and extremely stimulating address which he had delivered. It was an admirable send off to this Society. He should also like to add one word of welcome to this Society on behalf of his physiological brethren who, he feared, were not represented as fully at this meeting as they ought to be.

This Society he felt would become of great interest to physiologists. It would draw them into its clutches. He felt sure that physiologists would, in a short time, be found making useful contributions to the already useful work of this Society. On behalf of his physiological brethren, he wished once more to welcome the birth of the Illuminating Engineering Society, and felt sure that in the future they would be able to co-operate on topics of mutual interest.

At the conclusion of Dr. Haldane's

remarks, **Sir Boverton Redwood** rose and formally put the motion, which was carried unanimously amid loud applause.

Prof. S. P. Thompson, the President, then thanked those present for the kind manner in which they had received his address, and said that it would give him great pleasure for this address to be published in the official organ of the Society. He hoped to have the pleasure of presiding at many meetings during the coming session, and he felt sure that, when the time came for him to relinquish office, he would be able to look back to a period of enjoyable and useful work already performed by the new Society.

Mr. L. Gaster said he felt bound to acknowledge the kind terms in which his work in connection with the Society had been mentioned. Strenuous labour, he must confess, much of it had been, but it was a labour of love, and he was more than rewarded by hearing such an address as the President had delivered, and by the pleasure of seeing the Society's career opened by such a successful inaugural meeting.

He wished also to say how much was due to all those who had co-operated with him in furthering the interests of the Society and to make special acknowledgment of the assistance of his friend Mr. J. S. Dow, who had been his helper since the starting of the magazine in this country.

The President then announced that the next meeting of the Society would take place at the Royal Society of Arts, at 8 o'clock, on Tuesday, January 11th, when a discussion on "Glare, some of its Effects and Causes," would be opened by Dr. J. H. Parsons.

The meeting then terminated and most of those present adjourned to the library where tea and coffee were provided. All agreed that the first gathering of the Society had been a most successful one, and that the President's inspiring address had served admirably to portray the nature of the problems with which the Society would have to deal.

Facsimile of the Invitation Card to the Inaugural Meeting:—

The Council of the

Illuminating Engineering Society

FOUNDED IN LONDON, 1909.

requests the pleasure of the company of

....

at the Inaugural Meeting of the Society
which will take place at the premises of the
Royal Society of Arts, (John Street, Adelphi, London)
on Thursday, November 18th, at 8 p.m.,
when a brief report of progress will be presented by the
Hon: Secretary and an Inaugural Address will be delivered
by Professor Silvanus P. Thompson, D.Sc. F.R.S. the
First President of the Society.

R.S.V.P. to
Mr. L. Gaster, Hon: Secretary,
32, Victoria Street,
London. S.W.

Some Letters of Congratulation on the Formation of the Society.

THE following are a few of the congratulatory messages recently received from absent friends :—

Prof. A. Blondel (Vice-President, Paris).

I feel the greatest interest in the success of your work....I shall be very happy to assist in any manner towards the success of the Society.

Prof. H. Bunte (Vice-President, Karlsruhe).

I shall gladly support your efforts and wish you every success in the undertaking.

Mr. E. L. Elliott (Vice-President, New York).

I wish to congratulate you upon the splendid progress made....From the list of names which you append the Society is certainly one to which it is an honour to belong.

Prof. C. Feldmann (Corresponding Member, Delft).

In conjunction with Mr. J. Herzog, I have been engaged in discussing the art of illumination since 1893....Of course we are glad to see that things are progressing in the direction we foresaw.

Mr. W. H. Gartley (Vice-President, Philadelphia).

We look forward with confidence to an increased development through the harmonious action of the two societies.

Mr. W. R. Herring (Member of Council, Edinburgh).

I am of opinion that the Society will fill a gap that prevailed between the supplier and user of illuminants of all descriptions.

Herr J. Herzog (Corresponding Member, Budapest).

I have observed your efforts with great pleasure....they deserve every recognition. You are forming a centre of information in matters connected with illumination, and there is no doubt that this will be, in time, of very great benefit to all interested.

Sir Joseph Swan, D.Sc., F.R.S. (London)

I certainly am deeply interested in the objects of the new Society....my earnest wish that the Society may have a useful career.

Professor J. Teichmüller (Vice-President, Karlsruhe).

I am extremely sorry to be unable to be present at your Inaugural Meeting. I should be very grateful if you would kindly convey to the Society my best wishes for its prosperity. Rest assured that I, for my part, shall be only too glad to further the interests of the Society.

Professor Ubbelohde (Vice-President, Karlsruhe).

I wish the young Society a prosperous existence.

Professor L. Weber (Vice-President, Kiel).

I assure you of my warmest interest in the progress of the Illuminating Engineering Society.

Professor K. Ulbricht (Vice-President, Dresden).

Please convey to the Council of the Society my sincere thanks for the invitation. Unfortunately it is not possible for me to come to London, but I may tender my best wishes for the success of the Society thus inaugurated.

Shortly after the conclusion of the meeting many additional messages of congratulation were received.

The Hon. Secretary takes this opportunity of thanking all who have written, both before and after the meeting,

expressing sympathy with the aims and objects of the Society, and regrets that he has found it impossible, owing to the number of letters, to reply to each well-wisher individually. Special reference may be made, however, to an additional mark of sympathy of the Illuminating Engineering Society in the United States.

Mr. P. S. Millar informs us that the following resolution was adopted at the recent third annual Convention of the United States Illuminating Engineering Society :—

> "The Illuminating Engineering Society, in its third annual Convention, extends congratulations to the officers and founders of the British Illuminating Engineering Society on the progress made in establishing an association, and presents its assurances of hearty co-operation."

In addition the following cable has been received from Dr. L. Bloch, whose work in connection with illumination and photometry is well known in this country and who is one of the corresponding members of the Society in Berlin :—

Dr. L. Bloch gratuliert zur Eröffnung und wunscht besten Erfolg für die Zukunft.

Herr G. Dettmar, General Secretary of the Verband Deutscher Elektrotechniker, has also written expressing congratulations.

Among those who wrote, expressing regret at their inability to be present on this occasion, owing to indisposition, previous important engagements, and other causes, we may mention the following names :—Mrs. H. Ayrton, Professor W. Barret, Dr. E. Budde (V.P.), The Rt. Hon. John Burns, Prof. G. J. Burch, Mr. R. Brudenell Carter, Earl Cawdor, The Rt. Hon. Winston Churchill, Dr. M. Corsepius (V.P.), Prof. F. Clowes, Mr. Dugald Clerk, Sir Wm. Crookes (V.P.), Prof. H. B. Dixon, the Editor of the *Journal* of the Royal Society of Arts, Prof. Ewing, the Secretary of the Engineering Standards Committee, Sir Douglas Fox, Mr. Henry Fowler, Sir J. Gavey, Mr. W. Doig Gibb, Mr. Thos. Glover, Mr. Chas. Hunt, M. P. Janet, M. F. Laporte (V.P.), Sir Wm. Preece (V.P.), Prof. T. Mather, Prof. R. Meldola, Major O'Meara, Dr. J. H. Parsons (M.C.), and Mr. R. O. Patterson.

The Presidents of the following societies :—The British Optical Association, the British International Association of Journalists, the Incorporated Association of Municipal and City Engineers, the Institute of Gas Engineers, the Institute of Mechanical Engineers, the Institute of Sanitary Engineers, the Iron and Steel Institute, the Medico Legal Society, the Society of Medical Officers of Health, the Ophthalmological Society, the Newspaper Proprietors Association, the Physical Society, the Röntgen Society, the Royal Institute of British Architects, the Royal Meteorological Society, the Royal Photographical Society, the Royal Society, the Surveyors Institution, &c.

The Duke of Northumberland, Sir Wm. Ramsay, Sir J. Swan, Dr. W. E. Sumpner, Professor H. Smithells, Mr, Alexander Siemens, Mr. S. Y. Shoubridge, M. Th. Vautier, Mr. A. Vernon Harcourt, M. Violle, Sir Aston Webb, Mr. W. H. Y. Webber, Sir Wm. White, Mr. Alex. Wilson, Sir H. T. Wood (V.P.), &c.

Illuminating Engineering Society.

(Founded in London, 1909.)

Notice of Next Meeting.

As announced by the President at the conclusion of the Inaugural Meeting, the next meeting of the Society will take place on **Tuesday, Jan. 11th**, at 8 P.M., at the Royal Society of Arts (John Street, Adelphi, London), when a discussion on **"Glare, its Causes and Effects,"** will be opened by Dr. J. H. Parsons.

It is hoped that all members will try to be present on this occasion, and those who find themelves unable to do so, will bear in mind the possibility of communicating any remarks they may wish to make in writing to the Hon. Secretary, previous to the meeting, in order that they may be incorporated in the discussion.

The Illuminating Engineering Society.

(Founded in London, 1909.)

Inaugural Address.

By PROFESSOR SILVANUS P. THOMPSON, F.R.S., President.

Delivered at the Inaugural Meeting of the Society held at the Royal Society of Arts on November 18th, 1909.

IN these days when so many associations exist for the diffusion of knowledge and the promotion of various branches of science, industry, and art, the foundation of any new Society would be a proceeding of questionable expediency if it could not justify its claim to existence. To justify that claim, its founders must be prepared to show either that there has arisen some new science, industry, or art, or else that in the organization of the sciences, industries, and arts, there has arisen some real need which the existing societies and institutions fail to meet. Those who have founded the Illuminating Engineering Society, in whose name I have the honour of speaking to-night, have no hesitation whatever in putting forward the claim to justification on both these grounds, as will, I trust, be plain before the hour allotted to me is fled.

This Society has been founded to bring together all those who are interested in the problems, practical and theoretical, of *the art of directing and adapting* LIGHT, that *prime necessity* of civilized, as well as of uncivilized existence, *to the use and convenience of man.* By day the sun, by night the artificial sources, lamps of all kinds, provide mankind with light. But to utilize the light so afforded, properly, without waste, without excess, is an art, a business, concerned with many more things than the mere production of light. Few members of the community at large are producers of light, and those who produce light have many diverse and often rival processes. But all members of the community are users of light. And between the producer and the user there stands a considerable number of persons, mostly professional men, not middlemen in the industrial sense, but persons who are concerned with the intermediate questions of distribution and utilization, for whom no professional name has hitherto existed, and who have had no organization to bring them together, to consolidate their experience, or to voice their opinions. Their diverse and individual interests centre around a common topic—and, in default of a more appropriate name, that topic is called "*illuminating engineering.*" So far as this is their profession they are engineers —for is not the definition of engineering the art of directing the powers of Nature to the use and convenience of man? And since that which occupies them is not so much the production of *light*, as the utilization of it in *illumination* (that is in lighting other things), the term *illuminating engineering* becomes entirely appropriate.

To advance the subject of illuminating engineering; to investigate through all its lengthened breadth the facts within its domain; to increase and diffuse knowledge respecting them; and to unite those who are devoting their energies to these things, is the object of the Society. The ascertained facts are few—all too few; their significance is immense; their economic and social value is great; but the ignorance respecting them generally is colossal.

Nor is there cause for wonder either that the subject is not widely understood, or that no society has hitherto been organized to promote its interests. The subject is too new.

For practically a century only, have there been any systematic means of illumination, in use in any civilized country. Before the year 1800 there were as means of illumination: daylight, oil lamps, rushlights, tallow dips, and wax candles. Monarch and peasant, merchant prince and workman, had alike to depend on individual sources of

light at night. Only in the larger towns and cities was there any organized attempt to light the streets by oil lamps. In 1819, the authorities of the day stoutly resisted the proposal to light the then House of Commons by gas—nothing but wax candles could be admitted. But gas lighting was coming in; and Argand and colza oil lamps were the sole competitors until after 1850. Everything else has been introduced or invented since then—practically during the last half-century. For paraffin lamps were not widely spread till the sixties. Arc lighting, though tried for spectacular and lighthouse purposes from the fifties, did not come into public question until about 1879. Glow-lamps followed three or four years later. Still later came incandescent gas mantles, and acetylene gas lights; while the newest things in both gas lighting and electric lighting are affairs of only a year or two ago. Many persons now realize the immense stride made in the introduction of the Auer (Welsbach) mantle for incandescent gas; very many fewer people realize the significance of the corresponding step forward that has been begun by the introduction of the metallic filament glow lamp. We are on both sides in the very middle of an immense evolution in the art of illumination.

But whilst the means of illumination have thus been developing with amazing strides during a single generation, and the organized systems of distribution, by municipal and urban and rural authorities, and by private corporations, have ramified throughout the community and brought supplies of gas and of electricity—shall I also say of oil?—to our doors, there has been another and very different development going on. I refer to the growth of that branch of the science of Optics which deals with the measurement of luminous values. Photometry has been growing into an exact science by the exploration of its laws and the improvement of the instruments of measurement. For more than 200 years Optics has been peculiarly a British science. Not that we would forget the immense services rendered to Optics by such men as Fresnel and Arago in France, by Fraunhofer in Austria, and by Petzval or Kirchoff in Germany—to say nothing of recent workers. But Sir Isaac Newton, with his immortal treatise on 'Optics,' published in 1704, put England in the forefront of optical science. Yet, strange though it may seem, there is not in Newton's 'Optics,' nor in his posthumously published 'Optical Lectures,' a single line about measuring the brightness of lights or about illumination. The science of Photometry was not yet born. True, Kepler had, just 100 years before, in his 'Paralipomena,' announced that the intensity of illumination of a surface by light diverging from a point decreases in inverse ratio with the area over which it is spread: but it was not until 1760 that the first real discussion of photometric principles was made known. In that year Lambert in his 'Photometria,' laid down the fundamental laws, and likewise in the same year Bonguer gave to the world his 'Traité d'Optique,' wherein a primitive photometer was described. Rumford's shadow photometer was invented in 1794, and Ritchie's in 1824. Then comes a long gap. Save for Bunsen's over-rated grease-spot instrument, there was no important advance in photometry till the eighties, when there were produced many novel forms, some of them, including the now well-known forms of L. Weber, Lummer-Brodhun, and Rood, capable of yielding results of much higher precision in the comparison of different sources of light. Also in the eighties we meet for the first time with special forms of photometer of the kind destined to play a very important part in the work of our Society, namely, photometers measuring the values not of the brilliancy of a source of light, but the illumination of a surface.

Illumination! What irrelevant associations cling about the word which now and henceforth must be used in a restricted scientific meaning! The very earliest recollection of my childhood is that I was taken out one night to see the illuminations on the proclamation of peace after the Crimean War! Blazing torches, flaring tongues of

gas, Bengal lights and rockets :—How the vision of them stands out in memory. But our Society has as little to do with fireworks as with fire-flies. As little—and as much—for, after all, both of them are assuredly of some interest to the illuminating engineer; since nothing is without interest to us within the compass of the art of directing light to the use and convenience, or even to the amusement of man.

In truth our field of activity is wide enough. We deal, let us admit, with lighting rather than with light. But there is a vast scope indeed in the consideration of the proper lighting, by day as well as by night, of houses, offices, factories, shops, schools, hospitals, churches, theatres, halls, streets, squares, railway stations, shunting yards, mines, ships, and studios. Our primary concern is the adequate and proper illumination of things. And as we have to reduce the present chaos to an exact science, our first business is to secure some common agreement as to the measurement of illumination and the establishment of reasonable rules as to the amounts of illumination required in different cases.

Foremost then in the programme of work for our Society we put the question of the units of measurement, and the promulgation of the proper definitions of them. We must secure agreement—national and if possible international—as to what shall be taken as the unit of light, and what as the unit of illumination at a surface.

Happily, the long-standing controversy as to the former appears to be settling itself by at least a preliminary agreement between the standardizing laboratories of the great nations. One "candle" is no longer to be a vague and indefinite thing. The new definition provisionally agreed upon is an ideal unit, in terms of which one can describe the several standards in use in different countries. If this provisional *entente* can but be ratified by a little international common sense, we shall have henceforward an international "candle" such that it is the same in England as in America, equal to the "bougie decimale" accepted in France, and related to the Hefner-candle of Germany in the precise proportion of ten to nine. There is virtue after all in simple arithmetic. Existing standards will not be interfered with. We in London may use our 10-candle Pentane (or Vernon Harcourt) Standard, or our Fleming 10-candle standard electric lamp; while our German friends may peacefully bask in the ruddy rays of their 0·9 candle Hefner lamp, or our French neighbours enjoy their 10-candle Carcel. All this is to the good.

But we have still to find agreement on the standard of illumination. Here in England, and in the United States, we have already grown accustomed to describe amounts of illumination of surfaces in terms of a British unit—the "candle-foot"—not perhaps a very happy term—one that we would readily exchange for a better—meaning thereby the intensity of the illumination at a surface situated at the distance of one foot from a light of one "candle." The source being assumed here to be concentrated at a point, the law of inverse squares holds good. Therefore, as all illuminating engineers know, the illumination due to any point-source is calculated by dividing the number of "candles" of the source by the square of the number of feet that express the distance from the source to the place where its light falls. Since then one metre is equal to 3·281 ft., and the square of 3·281 is 10·765, it follows that, if we wish to express distances in terms of the metre, and the illumination in terms of the "*candle-metre*," one candle-metre will be only $\frac{1}{10\cdot765}$ of 0·09289 of a candle-foot. Or, putting it approximately, it takes a light of about 11 candles at the distance of one metre to produce an illumination equal to that produced by 1 candle at the distance of 1 ft. Equal illuminations are produced (*a*) by 1 candle 1 ft. away; (*b*) by a 16-candle glow lamp 4 ft. away; (*c*) by a 64-candle Welsbach mantle gas light 8 ft. away; (*d*) by a 144-candle Nernst lamp 12 ft. away; (*e*) by a 1,000-candle arc lamp 31½ ft. away. We are here dealing with the quantity of the illumination, not with its quality, that is to say, its colour.

Our Continental friends have tried to procure the adoption of the word "*lux*" to denote what here is called a "candle-metre"; *i.e.*, the illumination afforded by one candle at a distance of 1 metre. Unfortunately they have mixed up the definition of the "lux" with that of the unit of light, so that already the term is ambiguously used; hence, for the present, I avoid it, though I am quite prepared to adopt it if the ambiguity is removed by international agreement.

Adopting, then, for present purposes, the candle-foot as the unit of illumination, one may readily state certain facts with definiteness. All competent authorities are agreed that at night, for the purpose of reading—an illumination is required not less than 1 candle-foot: some authorities saying $1\frac{1}{2}$ candle-foot. [*Note.*—I don't say "candle-*feet*," any more than I say, as would be more correct, "candles-foot."] The facts appear to be that reading is impossible with an illumination of $\frac{1}{10}$ candle-foot; difficult and fatiguing with one of $\frac{1}{4}$ candle-foot; comfortable with from $1\frac{1}{2}$ to 3 or 4 candle-foot. But that if the illumination exceeds 6 or 8 candle-foot, the glare of the page is again fatiguing and dazzling. The page should neither be under-illuminated, nor over-illuminated. Something depends, it is true, on the size of the print. Under a feeble illumination of, say, $\frac{1}{2}$ candle-foot, a type of pica size printed in a fount of bold face properly-inked, is legible when one of long-primer size, printed in a weak way, would be practically illegible. Something also depends on the state of the eye as affected by the general illumination of the surroundings. Very seldom does one find in any ordinary room an artificial illumination exceeding 3 candle-foot. By day, on a writing table placed near a north window—or near any window not receiving direct sunlight—the illumination may exceed 3, and may even attain 4 or 5 candle-foot.

Until a unit of illumination was thus agreed upon it was impossible to render any reasonable certainty to estimates of the amount of illumination in any case of dispute. What is the meaning of the term "well-lit," as applied to any room, building, factory, workshop, or school? Formerly the term was entirely vague. To-day the answer can be given in numerical terms. Formerly judgment had to be made by the unaided eye; and the eye is notoriously a bad judge. As between two different illuminations, the powers of discrimination of the eye are very limited. The eye can equate, but it cannot appraise. It can tell with fair accuracy whether two adjacent patches are equally bright; if they are not equally bright it cannot say with any kind of proportionality what their relative brightnesses are. All photometry depends on the perception of an equality.

It is convenient here to remark that there are three quite distinct things which a photometer may be employed to measure.

(1) *Intrinsic brightness* or *Effulgence* of a source, the amount of which is usually expressed by saying it has a power equal to so many candles. Most of the photometers described in books on Optics are for this purpose. Their use implies the possession of some standard source—a standard candle, or a standard lamp—in terms of which the effulgence of the source in question is, after measurement, expressed.

(2) *Illumination at a surface*, to be expressed in terms of the candle-foot or of the candle-metre, or of the lux. It is independent of the nature or colour of the substance on which the illumination falls. As Mr. Trotter has somewhere said, illumination no more depends on the colour or nature of the surface than rainfall depends on the colour or nature of the ground it falls on.

(3) *Luminosity*, or *Specific Brightness of a Surface*. Of this there are two cases:—(*a*) The specific brightness of a source, which may be expressed in candle-power per square inch or candle-power per square millimetre; (*b*) specific brightness of an illuminated surface, which may also be expressed in terms of candle-power (in a normal direction) per square inch or per square millimetre. This is a quantity that varies enormously, depending on the illumination received, on the colour and

texture of the surface, and on the angle at which it is set to receive the illumination.

The photometry of the specific brightness of illuminated surfaces has been very little studied ; but is of extremely great importance. I do not forget the statistics given by Mr. J. D. Mackenzie, or those of Dr. Louis Bell, but more such are wanted.

Photometers, for the measurement of illumination have been mentioned already as coming first into notice in the eighties. One of the earliest in this country was that constructed by Sir William Preece, with the assistance of Mr. A. P. Trotter, for measurement of the illumination of side-walks and pavements of streets. It has been subsequently developed by Mr. Trotter, and as constructed by Mr. Edgcombe is a most useful and handy instrument, telling the amount of illumination directly in terms of the candle-foot. Another by Mr. Haydn Harrison measures the illumination, not on the horizontal, but at 45°. Almost equally early with the Preece-Trotter illumination photometer was the school photometer of Petruschewsky, apparently little known in this country. Most recent of this sort is the form due to Martens. Doubtless in the course of our meetings hereafter we shall have improved photometers of all kinds brought before us.

Those who may not yet have made acquaintance with the admirable series of articles on photometry which Mr. Trotter has been supplying month by month to the pages of *The Illuminating Engineer* can have little idea what a rich fund of information is to be found in them. I venture to predict that they will become a classic in the art ; and they ought to be reprinted in independent form for the enlightenment of engineers and of the wider public.

The principles and construction of photometers are matters that have interested me for nearly thirty years. About 1880 I brought out a form of wedge - photometer (modified from Ritchie's form), in conjunction with Mr. C. C. Starling, for electric light measurements. Later I gave to the Physical Society an investigation of the errors arising in photometry from the almost universal assumption that the law of inverse squares is fulfilled. In 1882 when lecturing at the Crystal Palace Exhibition, I gave diagrams to show the effect of the superposition of illumination from two or more lamps, and discussed the variations of illumination in a street between the places of maximum and the places of minimum illumination. Twelve years ago I described a tangent photometer, which has remained a mere optical curiosity. Three years ago, at the York meeting of the British Association, I gave a public lecture on 'The Manufacture of Light,' since published as a small book, in which I dealt with the subject from a popular standpoint.

It is a good many years ago that I suggested—and a similar suggestion came independently from Mr. James Swinburne—that in the crater of the arc lamp one might find a standard source of white light. I suggested a square millimetre of the crater surface as the standard, believing that it would prove always of constant brightness, because at a constant temperature—namely the temperature of the softening, or perhaps of the volatilization, of carbon. Subsequently the discovery by Mr. Trotter of certain curious rotatory phenomena in the crater put an end to these hopes. But before that —now thirteen years ago—something else occurred that made me lose confidence in my suggestion. Seeing that carbon has a higher melting point than any of the ordinary metals, and at these high temperatures reduces all oxides and sulphides, &c., to the metallic state, I was convinced that the addition of any metallic or earthy salts to the carbons of an arc lamp could not but reduce the temperature of the arc. I believe still that this is true. But the inference that I drew that *therefore* the addition of any foreign matter to the carbon pencils of the arc will reduce its luminous efficiency, has now been found to be incorrect. I reckoned without regard to the possibility of specific radiation, such as is produced from salts of calcium, sodium, barium, and the like as exemplified in the modern flame-arc lamp. It was

just thirteen years ago that one day a young man called at my laboratory with an introduction, and told me that he had discovered a way to make arc light carbons give out more light by impregnating them with some chemical substances. I was politely incredulous. I had tried that kind of thing myself before. I had made carbons in 1878 with admixture of pipe-clay, or chalk, or similar materials. My visitor was insistent. What his materials were he would not say—that was suspicious. But he still persisted: would I not try them ? I tried two of his samples—one alleged to be pure carbon, the other impregnated. Certainly it looked as though he might be right. But I was not satisfied, and my hesitation to be convinced must have sadly disheartened that young man. To put him to the test, I produced some of the purest carbons I knew of—they were Siemens's, uncored. I picked out four, and having marked them privately, gave him two to treat with his process, and kept the other, to control the result. He brought them back in a few days. Certainly his were brighter than those I had kept. To make sure I sawed down longitudinally one of his and one of mine, and we clamped two halves together, making a rod of the two semi-cylinders, and used it as the positive electrode in an arc lamp. I adjusted it so that the junction came right across the crater. An image of the arc was projected on a white screen with a lens. There would now be no doubt of the result, the two halves of the crater of the arc were unequally bright—the brighter half being that which had been treated. Later I was informed that salts of potassium, boracic acid, and other materials had been used for impregnating.

I have good reason to remember this old experiment—it destroyed my dream of an arc crater standard of white light; but it won me the friendship of Mr. Leon Gaster.

But to return to the laws of illumination. No one can have worked at the photometry of modern lamps, or of the illumination of surfaces lit by lamps, without becoming conscious how much misunderstanding there is of the elementary laws of illumination. There is Lambert's cosine law—admirable and simple—if only it were not in so many cases vitiated by the presence of organized—that is specular—reflection. There is that everlasting law of inverse squares, itself a universal geometrical law of action radiating from a point, so fatally and absolutely misleading if applied to any other case than that of action from a point. How often do we find it ignorantly dragged in. Not many years ago, a distinguished ophthalmic surgeon wrote in the columns of *The Times*, that the reason why a scarlet geranium looked less brilliant in tinc across a garden was because the brightness of its light varied inversely as the square of the distance! Not many months ago I read in one of the technical electrical journals an account of an elaborate investigation by two electrical engineers on the illumination produced by one of the newer electric lamps—a long vacuum tube, I think—in which the question was gravely considered how far its illumination departed from the law of inverse squares! As the law of inverse squares is a law of point action, and as a long vacuum tube is not exactly a point, one marvels that any person who could handle mathematical symbols should ever have imagined that it would act as a point, and radiate according to the law of point action. One would rather have expected that it would conform to the law of line-action—that the illumination sideways from it should vary simply inversely as the distance, and not as the square. I had some thought of saying more on this point in my Address; but not to prolong it unduly, I will simply print as an Appendix a table of the geometric laws of illumination in different cases.

One of the things that I think our Society might well undertake would be the formation—in the manner of the British Association or of some of our sister societies—of technical Committees charged with the duty of preparing reports on different branches

of our subject. In some cases such a committee would merely have to collect existing information from scattered sources; in other cases they might have to issue systematic inquiries by circular; in others they might have to enlist some one of themselves, or some outside person to conduct a research. One such subject, on which more information is badly needed, is the specific brightness of surfaces of different kinds when subjected to a standard illumination. For instance, let the question be put: How much light is reflected, per square inch, when illuminated with an intensity of 1 candle-foot, from such materials as oak panelling, whitewash, brown paper, or the surface of a red brick wall? Here in this theatre the walls are tinted of a dark Pompeian red or maroon which reflects but little light. The extra annual expense on lighting that might be saved had a lighter tint been used, is surely worth considering.

The subject of diffuse reflection which here comes into play has indeed been investigated partially by several persons. There are Dr. Sumpner's researches of 1894, and those of Mr. Trotter on white cardboard and other white matt surfaces, but how few others! Again there is the subject of diffuse refraction, which occurs in ground glass shades, ribbed and corrugated glass panes, and other devices for diffusing the concentrated light of lamps. Yet how little does any optical book tell us on the subject of diffuse refraction. Reflection and refraction as they occur at dull or irregular surfaces appear to be of no importance to the academic writer of text-books of Optics; but they are of vital interest to the illuminating engineer. Again, there are a number of semi-physiological problems that demand investigation and settlement. We all know that our eyes have an automatic diaphragm which stops down the entering light to protect our eyes from glare, rendering us relatively insensitive to bright lights. Does any one know whether the contraction of the pupil depends on the total amount of light entering the eye or on the intensity of the image on local patches of the retina?

Again we all know how an unshaded arc-lamp or even glow-lamp "cuts" the eyes by the very concentration of its beams, even when it may be many feet away; while the same actual amount of light if diffused over a greater apparent surface, as by a surrounding globe of ground glass, is quite readily endured, and does not produce the same painful sensation. Does any one know how great is the specific brightness of surface that the eye will tolerate without experiencing this discomfort? We can look at a white cloud, or at the blue sky without pain. Can we endure a specific brightness of as much as 1/10th of a candle per square inch?

Our eyes are provided by nature with a most exquisite and automatic iris diaphragm which opens in the dark and closes in the light, thereby shielding us partially against the evil effects of glare. Putting it in the language which the photographer uses to describe the stopping-down of a camera-lens, the automatic iris of our eye can close the pupil so that while in a comparative darkness the aperture opens to $f/2$ or $f/2{\cdot}5$; it closes, amid a brilliant surrounding illumination to about $f/20$. Suppose we are looking out in relative darkness, and are confronted with a brilliant patch shining with a specific brightness of 1/10th of a candle per square inch, we shall feel a certain amount of discomfort from its glare; and if we regard it steadily for a second or two, we shall, on closing our eyes or turning away, see those persistent coloured images that trouble us after looking at any very bright light. But now let the same brilliant patch be placed against a bright background. Far more light will enter the eye; the automatic iris of the eye will in a few moments have contracted, stopping down the lens of the eye so that it will be far less sensitive. In these circumstances will the patch that has a specific brightness of 1/10th candle per square inch pain or dazzle the eye? I ask the question; but I do not know the answer. Does any one know what the answer ought to be? It is a simple question; and a few experiments would

soon discover the answer. Of course, one must admit that the automatic action of the iris diaphragm, important as it is, does not by any means account for the whole of the facts about the want of proportion between the intensity of a stimulation and the intensity of the resulting sensation. Every one knows how we get used to sensations. If your hand is cold, and you plunge it into a bowl of moderately hot water, the first sensation is that of unbearable heat. But after your hand has been for some time subjected to the warm surroundings it becomes less sensitive and does not find the same high temperature unendurable. Fechner's logarithmic law of psychophysics gives a clue—but even this does not seem capable of expressing, much less of explaining, the facts about the observed want of proportionality. Why should a light of tenfold brilliancy not produce a sensation ten times as intense? And why should a greater brightness of the general surroundings relieve us of the annoyance of those coloured after-images? After-images can be seen even under extremely feeble illumination, as I have again and again found. Has any one discovered any exact law governing their occurrence?

All these queries show that there is plenty of work awaiting us, even in the mere collection and completion of such scattered information as is already available. But there are even more important questions before us: more important, not in science, but in their relation to the public welfare and the economics of the community.

Now that we have a standard of illumination and simple portable instruments that will measure it, there can be no excuse for inaction or ignorance in applying that knowledge to securing proper illumination for public and private buildings.

Let me begin with school buildings. They are the most important, for whatever bad results flow from bad lighting of churches, factories, or railway stations, those which result from the bad illumination of schools are far more to be deplored—they imperil the eyesight of the next generation.

I note that in a recent report by Dr. James Kerr, Medical Officer for Education to the London County Council, in the statistics of the Council Schools for the period April 1 to December 31, 1908, he found the lighting of 81 per cent. of the schools "good," 8 per cent. "fair," and 11 per cent "bad."

Now the inspection which thus judges the lighting of one school as "good," and another as "bad," is after all a mere *ipse dixit* of the inspector. He may be perfectly right: but he gives no facts or figures to support his judgment. Had he said, "I find in such and such a school, that the illumination in half the class-rooms is below 1 candle-foot: that in the large hall of the school by day, or an ordinary cloudy day in summer, it is 2 candle-foot near the west end, and only ¾ candle-foot on the desks half way down the side of the hall," one would know what he had to go upon. But has any one yet seen a report on the illumination of any school that gives any real data whatever?

The ophthalmic surgeons are all agreed that insufficient illumination is a prime cause of myopia, and that the myopia gets aggravated, a larger percentage suffering from it in the higher clasess. My brother Dr. Tatham Thompson, who is consulting Ophthalmic Surgeon to the Cardiff Infirmary, in a lecture delivered three years ago on the 'Influence of Early School Life on Eyeisght,' gave a summary of the results of various investigations of several authorities—chiefest Dr. Cohn of Breslau, Dr. Risley of Philadelphia, and Dr. Priestley Smith. It appears that in the years 1865–1866 Dr. Cohn examined the eyes of no fewer than 10,060 children in the schools of Breslau, and found 17·1 per cent, or nearly one-fifth of the whole, to have defective sight; and the percentage of those suffering from short-sight was only 6·7 per cent in the Elementary Schools, but rose to 26 per cent in the Higher Grammar Schools ("Gymnasia"), while in the University he found no less than 59·52 per cent—more than half—of the students to be short-sighted.

In 1881 Dr. Risley found in the schools of Philadelphia a progressive percentage, from 4·27 per cent in schools where the average age was 8½ years, up to 19·3 per cent. in the normal schools, where the average age was 17½ years. In Birmingham Dr. Priestley Smith found 5 per cent. of myopic children in the Board Schools, and 20 per cent of the students in a training college.

All ophthalmic surgeons agree that the cause which thus forces the children into increasing shortsightedness is protracted poring over books under an insufficient illumination. Even in what an inspector might call a well-lit school, the illumination at the surface of the desk may be quite insufficient if the desks are badly placed, or the windows insufficiently high, or the lamps badly distributed. Javal's rule as to blocking of light by neighbouring buildings, that the height of the opposite buildings should not exceed half the distance between building and building, is, in London at least, a counsel of perfection, and could not possibly be enforced, however desirable. Equally impracticable, in London, is Prof. Walter Scott's recommendation that "the amount of sky" visible from each seat in the schoolroom should be "large." The rule given both by Cohn and Risley, that there should be one square foot of window space for every five square feet of floor space, is also quite inadequate, and even misleading, if applied to London conditions. It is compatible with a miserable and totally inefficient lighting at the far end of the room, especially bad if the walls are not white or nearly white. It may also be remembered that the London Building Act (1894) requires for habitable rooms that there shall be one square foot of window area for every ten square feet of floor space.

Let us rejoice, however, that the London County Council has made a beginning of reforms, and has in Dr. Kerr secured a medical officer who is alive to the importance of this question. Their next step should be to request him to make a systematic numerical measurement with a simple portable illumination photomter, of the actual conditions existing in the schools. Then they will be in a position to instruct their surveyors and architects as to what are the real requirements that ought to be fulfilled in the future. All educational authorities ought henceforth to insist on rational requirements as to lighting. Hitherto they have had nothing definite to specify: now that illumination photometers are available they ought to require a minimum of 1½ candle-foot at the worst-lighted seat in the school-room; they must not depend on purely architectural rules about heights of windows or areas of window-space. In England the Board of Education in its Building Regulation (1907), Rule 6, clause *c*, has laid down a foolish rule: "Skylights are objectionable. They cannot be approved in school-rooms or class rooms." That perfectly monstrous provision ought to be at once repealed. The universal experience of the textile industries, where adequate lighting of spinning and weaving machinery is a prime necessity, is that no method of lighting is so satisfactory as skylights, in roofs specially constructed to receive light from the northern sky. Perhaps the wiseacres who framed this rule for school-rooms and class-rooms fear lest Heaven should look down into the dark corners.

Another point in school lighting is the proper treatment of ceilings. Dark oak beams, however handsome, waste a vast amount of light. Were ornament the dominant consideration no one would object. If a fashionable hostess in a West-End mansion chooses for a freak to paint her ceiling black, why should we oppose her? She will require all the more artificial lighting in consequence, and there will be more work for the illuminating contractor, and for the gas works or the electric supply station. And if out of the fullness of an artistic imagination a Raphael will decorate the ceiling of the Stanze in the Vatican of a deep sky-blue besprinkled over with myriads of little gold stars, who shall say him nay? His problem was not that of securing an economical and adequate illumination.

Nor ought we to forget that in schools as in all buildings there must not be an over illumination. Shadows are most useful; and shade to the eyes is grateful, and gives repose.

Hitherto little attention has been paid by either local or central authorities to conditions affecting the lighting of factories and workshops. It is true that the factory inspectors require periodic whitewashing of factories; but that is for sanitary reasons, not primarily to secure better illumination. But when we think of the wholly miserable conditions as to lighting under which many workers have to do their daily toil—the tailor stitching by the light of a single flaring gas bat's-wing burner—we may wonder that so little has been done. If I am correctly informed, the Home Office has laid down no rules about the illumination in factories, beyond the general requirement that the lighting must be "adequate." It rests with the inspector to say what he considers "adequate"; and until he is provided with an illumination photometer to take with him into different parts of the factory to measure the illumination there, or until some definite knowledge exists as to the proper amount required for the different trades and occupations, or for different machines and tools, the term "adequate" is almost meaningless. The Home Office has its regulations as to temperature and degree of moisture required or permissible in the different classes of factories and workshops. Then why not also similar regulations as to the proper amount of illumination? Surely the eyesight of the workers is as well worth protecting from injury as their lungs and their limbs. So far as I am aware, Holland is the only country in which legislation has fixed a statutory amount of illumination in factories, the figure there being from 10 to 15 candle-metre; equivalent, therefore, broadly, to the value of 0·9 to 1·35 candle-foot.

The recognition of the illumination photometer will do much to put on a satisfactory footing a matter which has long been a considerable scandal in the law courts, the contradictions of expert witnesses who appear in actions for damages to "ancient lights." It is many years since I had anything to do with any such cases, but I well remember one, where an owner of property was claiming damages for a prospective interference to his rights of light by the erection of new buildings which shut off from one side a portion of the daylight. Having no proper portable photometer in those days, and not being satisfied with mere inspection or guessing, I had recourse to a Crookes's radiometer. It was for this purpose assumed that the speed of the little light-mill was proportional to the illumination it received. We took it to the far end of the rather dark room, and counted the number of revolutions per minute which it made. Then we erected outside the window a barrier of the right size to cut off the light which the new building, when erected, would cut off, and then counted the revolutions again. The number was smaller—how much smaller I forget; but, however defective, as compared with the use of a modern illumination photometer, the method was at least an honest attempt to bring scientific precision into a notoriously vague subject. For my sins, I have had to serve several times on Middlesex Special Juries. One time, I well remember, we had to assist the learned judge in trying a trumpery action for damages by an old lady who had stumbled over a barrow in a dark part of a platform in Clapham Junction Station. We had our suspicions that the case would never have been heard of but for the attentions of the enterprising solicitors, who conducted the plaintiffs' case; and as a matter of fact the action failed. But the thing that struck me most in that case was the contradictions in the evidence offered as to the lighting of the spot where the accident was alleged to have happened. Had a Trotter illumination photometer been available, the Court might have had the exact facts before it, instead of being obliged to consider whether the witnesses for the plaintiff or for the defence were the greater liars.

It is the earnest hope and expectation of the founders of our Society that a

very influential section of its membership will belong to the profession of architects and surveyors. Architects are often blamed for deficiencies in the lighting of the buildings they design; perhaps more often for the deficiencies found at night by artificial lighting than for those of the lighting by day. For this the fault rests no doubt largely with the persons who have installed the lighting arrangements. And one must not blame the architect too severely for having been as ignorant as all the rest of the world about the principles of illumination. But henceforward, when once it is known how much illumination is required in the rooms of different kinds, the architect ought in his specification to set down, with appropriate numerical values, what degree of illumination is required in the various parts of his building. It will not now suffice to go by any old rough-and-ready lumping—so many square feet of floor, therefore so many candle-power wanted in that room. Such a rule leads to terrible complaints. One could tell tales of miserable blunders resulting from a neglect (or ignorance) of the most elementary matters—of the architect who sub-let a contract for lighting a big building in which one large room was to be a mechanical engineer's drawing office, and allowed the contractor to specify no more light and no different arrangements of light than for a room of equal size to be used as ordinary commercial offices. But there are, on the other hand, architects who, as the pages of our official organ, *The Illuminating Engineer*, amply demonstrate, thoroughly understand and enter into this question, and are already putting the illumination requirements of buildings into their schedules and specifications. Need I go further than to refer to several excellent articles in our organ by Mr. P. J. Waldram. I would also mention that I have lately seen an excellent article in the Architectural Association *Journal*, by a well-known consulting engineer, Mr. R. J. Wallis-Jones, in which he gives the results of measurements made by himself of the illumination of a number of public places. Let me also not forget to commend to the notice of all municipal surveyors and lighting committees the admirable scientific Report made in 1908 to the Streets Committee of the Corporation of the City of London by Mr. A. A. Voysey, dealing with the illumination found in various streets with different systems of lighting.

I venture to suggest that it would be a good thing if, in the public interest, our Society, or some Committee appointed by it, could draw up a model specification, or model clauses for architects to insert in their specifications, in which the proper way of prescribing the requisite amounts of illumination, in different classes of cases, should be set forth.

But outside all these matters of more public interest, there are topics enough to occupy our Society for many months to come. We shall have discussions on several interesting subjects during next spring, and there are many problems awaiting solution. When all else fails us, we can turn to the eternal question of the measurement of colour. We have also the long outstanding problem of the production of light without heat—accomplished in nature by the firefly, but unrealized by any artificial lamp. We might turn to discuss special cases, such as the flashing lights of lighthouses, or the special lights needed in the hospital for the detection of rashes or the treatment of disease. Amid such endless ramifications of our subject there is no fear of coming to a premature end of our programme. There is, indeed, abundance of work before us.

I trust, therefore, that before long our Society will become generally recognized as one of public utility, having a real purpose to fulfil, and attracting to itself members who are active and zealous in promoting the object which it subserves. The eminence of those foreign members who have already consented to associate themselves with us, is a guarantee of the importance they attach to our aims.

We begin our work with confidence and hope, modestly calling ourselves

the Illuminating Engineering Society, a style which does not confer, and is not intended to confer upon its members any professional status. We shall, at any rate for the present, require no professional qualification for membership, but shall welcome all who take an interest in any branch of our work. But, speaking strictly for myself, let me confess that my ambitions do not stop short here. I look forward to the time—it may be ten years, or it may be twenty years hence—when by good work, such as the publication of papers of standard merit and permanent value, and the holding of useful and fruitful discussions, we shall have established our claim to become more completely an organized body, an Institution of Illuminating Engineers. But that is for the future; contingent, perhaps visionary.

Meanwhile, we have an immediate and direct function to discharge, in the collection, discussion, and dissemination of knowledge; and in arousing the interest of the public and of public bodies to the economic and social importance of the questions for which we are now united together as a Society.

To sum it all up, the work before us is to diffuse the light.

APPENDIX.

Compendium of the Geometrical Laws of Illumination.

In the formulæ which follow, the symbols have the following meanings:—

a = area of surface of the source (if such as a disc).

c = candle power of source (if the source is a point).
= candle-power per unit length (if the source is a line).
= candle-power per unit area (if the source is a surface).

r = distance from source to the place in question.

$n = \frac{1}{r}$ = the nearness of the place in question to the source.

θ = angle subtended by the length of the line source.

ϕ = angle measured from horizontal up to the end of the line source.

β = angle of the direction from the source to the place in question, as measured from the normal at the surface.

ω = the solid-angle subtended by the source, at the place in question.

I.	The Illumination from a **Point**	$\frac{c}{r^2}$	or cn^2.
II.	The Illumination from a **Line** (indefinitely long).	$\frac{\pi i}{2r}$	or $\frac{1}{2}\pi in$.
III.	The Illumination from a **Line** (short, subtending angle θ).	$\frac{2i}{r}\sin\frac{\theta}{2}$	or $2in.\sin\frac{\theta}{2}$.
IV.	The Illumination from a **Plane** (indefinitely extended).	$2\pi j$	
V.	The Illumination from a **Disc** (subtending solid angle ω).	$j\omega$	
V(a).	The Illumination from a **Disc** (of area a, at distance r).	$\frac{aj}{r^2}$	or ajn^2.
VI.	The Illumination from a **Vertical Line** (as measured on floor).	$\frac{i}{4x}(\cos 2\phi_2 - \cos 2\phi_1)$.	
VI(a).	The Illumination from a **Vertical line** (as measured on wall).	$\frac{i}{4x}(2\phi_2 - 2\phi_1 + \sin 2\phi_2 - \sin 2\phi_1)$.	

N.B.—In the cases I. to V(a) the expression is for the Illumination as received on a surface set normal to the direction of incidence. If the receiving surface is not normal to that direction the expression must be multiplied by the cosine of the angle which the surface makes with that direction, *i.e.* cos β. In cases II., III., and IV., the distance is taken as the *shortest* distance between the place in question and the source. In VI. and VI(a) x means the horizontal distance. In VI(a) the angle ϕ should be expressed in radians.

The Illuminating Engineering Society.

(Founded in London, 1909.)

REPORT OF THE COUNCIL.

Report presented at the Inaugural Meeting of the Society, held at the Royal Society of Arts, London, on Nov. 18.

WITHIN the last few years there has been a great development in methods of illumination, and there is now at the disposal of the consumer a bewildering variety of illuminants. At the same time, changed industrial conditions have led to our using much more light than in the past, and taxing our eyes in reading, by the injudicious placing of powerful lights, &c., to a much greater extent than a few generations ago.

This has naturally led to a strong sense of the value of a Society capable of dealing impartially with problems of illumination, and the successful career of the Illuminating Engineering Society in the United States, which has now been in existence for several years, has strengthened our view that an organisation with similar aims, in Europe, might do very useful work.

The existence of the Illuminating Engineering Society in this country may be said to date from February 9th of the present year, when an informal dinner, attended by a number of gentlemen, representing various trades and professions, who were interested in the formation of the Society, was held at the Criterion Restaurant, Piccadilly, London.*

On that occasion the Hon. Secretary, Mr. L. Gaster, briefly summarised the steps in the progress of the illuminating engineering movement in this country. He explained that in 1906 he had invited those interested to co-operate with him in order to found such a society, and a number of gentlemen then came forward. Subsequently, however, he felt that the time was not quite ripe for the initiation of a truly representative body and in 1907 he paid a visit to the United States and had the opportunity of learning the experiences of nearly all the prominent authorities who had been instrumental in promoting the Society having similar aims in that country. Subsequently he paid a visit to the Continent with the object of interesting the best known authorities in lighting in the movement. There, as in the United States, the idea met with enthusiastic approval, many of those who promised their support also consenting to act as contributors to the journal. Shortly after his return he assumed the editorial charge of *The Illuminating Engineer*, which was first published in London in January, 1908.

At this time it was felt to be necessary to devote some time to bringing home the need for the Illuminating Engineering Society and to educating the public to its aims and aspirations. The hope was expressed, and has been amply justified, that the journal would be the means of illustrating clearly the nature of the work which the Society would be called upon to perform ; also that it would act as a centre and means of collecting together all those interested in the subject of illumination who would afterwards form the nucleus of the Society.

During this time it was noticeable that more attention came to be devoted to matters connected with illumination in the technical press, and the attitude in many quarters towards the movement became increasingly favourable as its nature became more fully understood.

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* *Illuminating Engineer*, London, March, 1909, p. 154.

The journal, having thus become identified with the preservation of an impartial and international attitude, and having received influential support both in this country and on the Continent, it was next suggested that it should become the official organ in order that the Society might be able to profit by its existing connection and reputation. By so doing, one of the main difficulties in starting a new society, namely, the expense involved in publishing transactions, would also be reduced to a minimum, and the Society would thus start under exceptionally favourable conditions. The directors of the Illuminating Engineering Publishing Co., Ltd., were then approached on the subject, and expressed themselves as agreeable to the utilization of a certain amount of space in the journal for the publications of the Society.

Since the starting of the journal, much had been done to educate public opinion, and it was felt that, with the opening of the year 1909, the time was ripe for active steps to be taken in forming a Society. The general feeling of those present at the dinner referred to was strongly in favour of starting the Society without further delay, and a committee, representative as far as possible of the various professions and trades interested, was appointed to consider the framing of statutes, &c.

This committee held a number of meetings during the ensuing months, their attention being mainly concentrated on the framing of a draft constitution. It was recognized as necessary to make special provisions for the selection of the Officers and Council to be at once representative and impartial. [In passing, it may be remarked that all this discussion was throughout of an entirely amicable character, and in full accordance with the convictions of the founders of the Society that representatives of different systems of lighting and different aspects of illumination can meet together in perfect harmony to discuss matters for their common benefit.]

Having eventually drawn up a draft constitution of the Society the Committee reported at a meeting of the supporters held at St. Bride Foundation Institute, London, on May 25th. At this meeting the Draft Constitution was passed, subject to certain modifications of detail such as legal considerations might suggest, and was subsequently published, together with an account of the meeting in *The Illuminating Engineer.**

The existing Committee was also reappointed with power to add to its number, and thereby form the nucleus of the Council of the Illuminating Engineering Society. The Council, although very representative, does not as yet contain the maximum complement of members, it having been thought advisable to leave some vacancies to be filled up as occasion might demand. A list of the existing members up to date has now been published.

The Council next proceeded to consider the question of election of a President and are happy to report that Prof. Silvanus Thompson has kindly consented to act as President; the Society may consider itself singularly fortunate in possessing as first President one who has devoted so much attention to the scientific aspects of illumination, and has taken a great deal of interest in all methods of lighting.

In addition the Council have approached a number of authorities in different countries with a view to their becoming Vice-Presidents of the Society. Here again they have been fortunate in securing exceptionally influential and international support, as will be seen from the list of Vice-Presidents accompanying this report. It may be added that in the few cases in which, owing to pressure of work and other causes, those approached have regretted their inability to take an active interest, they have also spoken in warm terms of the value of the movement. The Society may congratulate itself on starting with a membership of over 150, including so many distinguished authorities.

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* *Illuminating Engineer*, London, June, 1909, p. 375.

One feature of the Society's programme may here be emphasized, namely, its international organization. With a view to securing as wide an outlook as possible on matters of illumination, the Council have taken special pains to invite the co-operation of distinguished authorities on lighting, photometry, &c., in different countries. With this object the Hon. Secretary recently repeated his visit to the Continent, and was able to hear the views of nearly all the great Continental experts in various subjects on the aims of the Society. All expressed their conviction of the value of such a body, and promised their cordial support. In order to secure additional representation, special provision has also been made in the Statutes for the inclusion of Corresponding Members, who are willing to aid the Society from time to time by their advice on local questions, or in connection with aspects of illuminating engineering on which they are recognized authorities. The Society has already been able to secure Corresponding Members in many of the chief Continental and American cities, and hopes to extend the list still further in the future.

Naturally it is hoped that the existing representation may be made even more complete, as the value of the movement comes to be more and more generally appreciated.

Another matter which has received the attention of the Council has been the question of giving the Society the proper legal status. In this connection they have been fortunate in securing the services of Messrs. G. M. Light & Fulton, who have kindly undertaken to act as Honorary Solicitors, and are now taking the necessary steps.

Having, therefore, briefly indicated the various steps in the formation of the Society, and the nature of the work on which the Council has been engaged, a few words may be said as to our aims, objects, and aspirations. Only a few words are necessary, as the President will deal with the matter in his address.

In the first place it is desirable to state that the main object of the Society is simply to provide an impartial platform where questions connected with illumination may be discussed. Among those interested in the formation of the Society it has been recognized that, owing to the absence of such a platform, there has been a tendency for misleading or one-sided statements to be circulated and there are many questions which are allowed to remain in a vague state, and on which authoritative information is badly needed. It is therefore desirable to provide a common meeting ground, not only for engineers connected with different systems of lighting, but also for members of the medical, architectural, and other interested professions; through the free exchange of views thus brought about it is hoped that not only will those connected at present with some particular aspect of illumination learn from one another, but that eventually a certain number of experts fully qualified to take a wide and impartial view of the whole problem will be evolved. The ideal expert of this kind has been called "The Illuminating Engineer," and there are doubtless many matters of public importance, such as street lighting and the illumination of schools, hospitals, libraries, museums, and other prominent public buildings in which his services would be invaluable.

But for the present the career of the Society will be largely one of mutual education and the spreading of knowledge among the general public. By joining the Society a member only expresses his interest in the movement and his belief that he personally can improve his knowledge of some matters and give information on others with which he is exceptionally well acquainted. It is therefore hoped that the Society will be instrumental in raising the standard of knowledge of illumination among those who, in one capacity or another, are at present engaged in problems of lighting. Membership in the Society does not by itself qualify anyone to be recognized as an "illuminating engineer."

The ground to be covered by papers is naturally extremely wide, and there are many points of common interest to those connected with all illuminants. The nature of the papers delivered at the past three Conventions of the Illuminating Engineering Society in the United States, and the amicable and stimulating discussions to which they gave rise, suffice to show that there is plenty of matter which can be discussed for the common benefit. But, at the same time, the Illuminating Engineering Society, having expressly framed its Constitution with a view to impartiality, can justly claim to be in a position to deal with problems in which the spheres of influence of the different illuminants are concerned, in a manner in which no other society can do. Under these conditions the claims put forward by representatives of one or other illuminant will be examined impartially and the possibility of misunderstandings or one-sided discussions reduced to a minimum.

In reality, the ground which it is desirable to cover in a session is almost too wide to be treated in the course of the meetings available. It is hoped, however, that the Society will be able to cover additional ground in the future by organizing courses of lectures to deal with elementary matters, or with detailed questions which appeal to experts of a certain class, but are not such as would be suitable for prolonged discussion at a general meeting.

In the future the Society also hopes to be instrumental in organizing Congresses for the discussion of points of special consequence and exhibitions of the most recent developments in lighting and photometrical and measuring apparatus.

In addition, it is hoped eventually to be in a position to accumulate information and to deal with technical points by means of committees of specialists. In such cases, it is suggested, the international connection of the Society will be specially valuable, as it will enable the Society to be in touch with experts in all parts of the world, and, if necessary, to organise series of researches in different countries on a common and predetermined course of action. It is also anticipated that the international connection of the Society will enable it to be specially instrumental in dealing with points of international importance, such as questions connected with units, nomenclature, standardized conditions of testing, &c. At present it is recognised that owing to the difference in the conditions under which researches in various countries are carried out, the results obtained are often not inter-comparable.

In the meantime, the Council trusts that members will do their best to extend the scope of the Society by inducing others interested in illumination to join, and by assisting in making known the aims and objects for which it was created.

The Council will also welcome suggestions from members regarding subjects which might be discussed, or researches which the Society might fitly institute or encourage.

By Order of the Council,
LEON GASTER, *Hon. Sec.*

The Illuminating Engineering Society.

(Founded in London, 1909.)

Committees on Finance and on Papers and Editing.

At a meeting of the Council held at the Royal Society of Arts on November 10th, the following two Committees, to deal with Finance and with Papers and Editing respectively, were nominated, with power to add to their numbers, it being understood that the President, Hon. Secretary, and Secretary should be *ex officio* members of both.

Committee on Finance, Mr. Chas. Hastings, Mr. J. W. Ife (Treasurer), Col. W. F. Leese, Mr. H. S. Smith, Mr. R. J. Wallis Jones.

Committee on Papers and Editing, Dr. C. V. Drysdale, Mr. F. W. Goodenough, Mr. S. Hamp, Mr. Haydn T. Harrison, Dr. J. H. Parsons.

The Illuminating Engineering Society.

(FOUNDED IN LONDON 1909).

LIST OF OFFICERS AND MEMBERS, NOVEMBER 1909.

(SUBJECT TO REVISION).

PRESIDENT.

PROF. SILVANUS P. THOMPSON, D.Sc., F.R.S., Past President of the Inst. of Electrical Engineers, Professor of Electrical Engineering and Principal of the City and Guilds of London Technical College, Finsbury, E.C., "Morland," Chislett Road, W. Hampstead, LONDON, N.W.

VICE-PRESIDENTS.

DR. LOUIS BELL, Consulting Electrical Engineer of the Edison Electric Illuminating Co., 120, Boylston Street, BOSTON, U.S.A.

PROF. A. BLONDEL, Professor of Electrical Engineering, Chief Engineer of the Lighthouse Service, France, 41, Avenue de la Bourdonnais, PARIS.

SIR JAMES CRICHTON BROWNE, F.R.S., Vice-President and Treasurer Royal Institution, &c., 61, Carlisle Mansions, LONDON, S.W.

DR. E. BUDDE, Professor of Electrical Engineering, Manager of Messrs. Siemens & Halske, Berlinerstr. 54, CHARLOTTENBURG, Germany.

PROF. H. BUNTE, Ph.D., Professor at the Technische Hochschule, KARLSRUHE, Gen. Secretary of the Verein von Gas- und Wasserfachmännern, Editor of the *Journal für Gasbeleuchtung*.

DR. M. CORSEPIUS, Consulting Electrical Engineer, Professor at the Königliche Vereinigte Maschinenbauschulen, COLOGNE.

SIR WM. CROOKES, F.R.S., M.I.E.E., &c., Past President of the Inst. of Electrical Engineers, Chem. Soc., British Assoc., &c., 7, Kensington Park Gardens, LONDON, W.

PROF. H. DREHSCHMIDT, Chief Chemist of the Municipal Gas Works, Tegel, BERLIN.

E. L. ELLIOTT, Editor of *The Illuminating Engineer*, New York; one of the founders of the Illuminating Engineering Society in the United States, 36, West 39th Street, NEW YORK, U.S.A.

DR. A. H. ELLIOTT, Chief Chemist and Director of the Consolidated Gas Co., Treasurer of the Illuminating Engineering Society (U.S.A.), 4, Irving Place, NEW YORK.

PROF. J. A. FLEMING, D.Sc., F.R.S., M.I.E.E., &c., Professor of Electrical Engineering at University College, Gower Street, LONDON.

W. H. GARTLEY, Chief Engineer of Philadelphia Gas Works, Past Vice-President of the American Gas Institute, President of the Illuminating Engineering Society (U.S.A.), Broad and Arch Street, PHILADELPHIA.

DR. J. S. HALDANE, F.R.S., Professor of Physiology at Oxford University, Gas Referee, &c.

DR. H. KRÜSS, Manufacturer of Optical and Photometrical Apparatus, Chairman of the Photometrical Committee of the Verein von Gas-und Wasserfächmannern, Adolphsbrucke 6, HAMBURG, Germany.

V. R. LANSINGH, General Manager of the Holophane Glass Co., Late Gen. Secretary of the Illuminating Engineering Society, N.Y. (1909), 50, Church Street, NEW YORK, U.S.A.

F. LAPORTE, Civil and Mining Engineer, Assistant Director of the *Laboratoire Central d'Electricité*, 12 and 14, Rue de Stael, PARIS.

PROF. VIVIAN LEWES, Mem. Inst. Gas Engrs., Lecturer at the Royal Naval College, Greenwich, City Gas Examiner, &c., 30, Crooms Hill, Greenwich, LONDON, S.E.

L. B. MARKS, Consulting Engineer, First President of the Illuminating Engineering Society (U.S.A.), Terminal Building, Park Avenue, and 41st Street, NEW YORK, U.S.A.

SIR WM. PREECE, K.C.B., F.R.S., &c., Consulting Electrical Engineer, Past President of the Institutions of Electrical and Civil Engineers, Gothic Lodge, Wimbledon, LONDON.

SIR BOVERTON REDWOOD, D.Sc., F.R.S.E., F.I.C., Consulting Chemist, Adviser on Petroleum to the Home Office, &c., 4, Bishopsgate Street, Within, LONDON, E.C.

DR. C. H. SHARP, Past President of the Illuminating Engineering Society (N.Y.), Chief of the Electrical Testing Laboratories, 80th Street, East End Avenue, NEW YORK, U.S.A.

L. A. STOKES, F.R.S., B.A., Vice-President of the Royal Institute of British Architects, 2, Great Smith Street, LONDON, S.W.

PROF. J. TEICHMÜLLER, Ph.D., Consulting Electrical Engineer and Professor of Electrical Engineering, Member of the Photometrical Commission of the Verband Deutscher Elektrotechniker (1909), Nowackanlage 2, KARLSRUHE, Germany.

PROF. UBBELOHDE, Ph.D., Gen. Secretary of the International Petroleum Commission, TECH. HOCHSCHULE, KARLSRUHE, Germany.

PROF. DR. ULBRICHT, Consulting Electrical Engineer and Professor of Electrical Engineering, Member of the Photometrical Commission of the Verband Deutscher Elektrotechniker, Hettner Str. 3, DRESDEN.

PROF. L. WEBER, Professor of Physics at the University of Kiel. Moltkestrasse 60 ,KIEL, Germany.

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Illuminating Engineering Society.

FOUNDED IN LONDON, 1909.

ADDITIONAL NEW MEMBERS.

SINCE the issue of the First Provisional List of Members of the Society, which was distributed among those present at the Inaugural Meeting, a number of applications have been received, and the names of several new members have been incorporated in the above list. Thus the names of Mr. E. P. Barfield, Mr. J. G. Clark, Major G. C. Glyn, Dr. J. S. Haldane (V.P.), Mr. Stanley Hamp, A.R.I.B.A. (M.C.), Mr. C. Ingrey, and Mr. J. Williams have been so added.

In addition several gentlemen have since expressed their desire to join the Society, among whom we may mention:—

Mr. H. R. Beeton (Chairman of the Brompton Electricity Co.), Mr. A. H. Dykes, M.I.E.E., Mr. J. Findlay (Managing Director of the Rugby Lamp Co.), Mr. H. W. Handcock, M.I.E.E., Mr. M. Pal, and Mr. T. Pye (Chichester Gas Works).

The Council hope that the inspiring address of the President will induce many to come forward and join the Society. Any one desiring to become a member is invited to communicate with the Hon. Secretary, Mr. L. Gaster, 32, Victoria Street, London, S.W.

Ultra-Violet Rays and Disease.

SOME CONFLICTING SUGGESTIONS OF DIFFERENT AUTHORITIES.

Readers of our journal have from time to time had opportunities of hearing of the most recent suggestions regarding the effect of ultra-violet rays on the eyes. Much of the information relating to this matter has been summarized by Dr. J. H. Parsons in a recent number of *Science Progress*.

But, apart from the question of their effect on the eyes, there are respects in which the action of these rays seems to be important—many of them the subject of much controversy between the physiologists at the present time. Several workers have drawn attention to the value of ultra-violet light in killing bacteria. This has been particularly dwelt upon in connexion with tuberculosis, and stress has frequently been laid upon the importance of providing free access to sunlight in interiors so as to remove the conditions which favour the growth of germs of this kind. As an illustration of experiments in this direction we notice a paper presented by Dr. J. Weinzirl at a recent Tuberculosis Congress in Washington, U.S.A. The author describes a series of experiments on tuberculosis and other germs, such researches invariably showing that the bacteria succumb more or less quickly when exposed to diffuse daylight. Direct sunlight is much more speedy in its action, some varieties of bacteria being killed in a few minutes.

A totally different view seems to have been recently put forward in the *British Medical Journal* by Dr. Watkins Pitchford, the Government pathologist in Natal, who has put forward the suggestion that cancer may, in some measure, be regarded as a result of direct exposure to ultra-violet light. Under certain conditions, therefore, it is suggested, ultra-violet light, so far from being beneficial, would seem actually to stimulate disease.

We also notice in the *Westminster Gazette* a reference to the work of Prof. Grawitz of Charlottenburg, who, it is stated, warns people in the *German Medical Weekly* against the present craze for sun-baths, which he declares often have very injurious results. "Although light-treatment may prove beneficial for particular ailments, there is no evidence whatever to show that it is invariably beneficial to the whole organism. Polar expeditions and other experiences prove that the absence of sunlight for whole months causes no harm to the organism; and for thousands of years civilised man has been accustomed to exclude all light from the greater part of the body. When the unaccustomed body is exposed to strong sunlight bad results often ensue. Inflammation of the skin is only a minor evil, but light baths affect the heart injuriously in more than one way, and sometimes cause collapse. The temperature is unduly raised; headaches are suffered from, and there results a general excitation of the nervous system."

We mention these instances of conflicting points of view with regard to the influence of ultraviolet rays merely as an instance of a case in which co-operation is needed in order to frame definite rules for the public guidance. The matter is of interest to us mainly because certain observers have suggested that the percentage of ultra-violet energy in the spectrum of artificial illuminants is tending to become greater than in the past, and if this is so we naturally seek to enquire how they should modify our present methods of lighting. A problem for physiologists is to decide upon the most favourable conditions which we ought to seek to reproduce both in daily life and for special treatment.

Selective Radiation from Metals.

By W. W. COBLENTZ.

THE question of the luminous efficiency of incandescent filaments has occupied the attention of experimenters from the earliest work on the so-called glow lamp. Evans* described comparisons of the radiation from bright and from black incandescent lamp filaments of carbon, in which he demonstrated very clearly the superiority of the former as a source of light. He selected, for this purpose, two filaments of similar size and structure, upon one of which he deposited a silver gray coating of carbon, and upon the other a hard coating of carbon of the colour of lamp black. He showed that for the same energy input the bright filament emitted the most light. The lamp bulbs containing the black filaments were found much hotter than those containing the silver gray filaments. He remarks: "I have little doubt that the loss of efficiency when black was due to the energy supplied being radiated in large quantities as heat waves from the blackened surfaces, which these surfaces, when bright, would not emit." Weber† showed that the total radiation of the untreated carbon was very much greater than the flashed when operated under similar conditions. These observations were verified by Nichols‡, who investigated the distribution of energy in the spectra of two lamp filaments similar in every respect except that, after they had been flashed, the one was given a thin coating of crabon by smoking. The lamps could be brought to incandescence separately, but were sealed together in such a manner that whatever changes in vacuum occurred in the one would be shared by the other lamp. He found that the untreated filament emitted much more energy in the infra red than did the treated filament, when operated on the same energy input. Continuing this inquiry as a side issue to the main work on the radiation constants of metals, the writer* published a series of spectral energy curves in which the various filaments were set to the same emissivity at a given wave-length, which was taken at 0·7. The results having been given considerable publicity and the "colour match"† method of making some of the comparisons being open to criticism, because the eye is lacking in sensitiveness in the red where radiometrically the energy already assumes large values, it was deemed of importance to repeat the work in order to show the defects in making comparisons which depend upon physiological stimulus to the eye.

The bolometric method of comparing spectral energy curves was described in the Bureau of Standards *Bulletin*, vol. 5, p. 358. Since the emissivity of the filaments is different, it would be difficult to obtain an intensity match bolometrically, at a given wave-length, without varying

* Evans, *Proc. Roy. Soc.*, Feb. 18, 1886.
† Weber, *Phys. Rev.*, 2, pp. 112 and 197, 1894.
‡ Nichols, E. L., *Phys. Rev.*, 2, p. 260 1894.

* *Bulletin of the Bureau of Standards*, Vol. 5, p. 339. 1908.

† The Method of comparison of light sources, by matching them in colour with a photometer sensitive to colour differences, was described by Nichols in 1894 (*Phys. Rev.*, Vol. 2, p. 166), and the present variation in the method, as applied to radiators in general, is objectionable, because it is not admissible to apply a "color-match" or even a bolometric test to one part of the spectrum, and then attempt to draw conclusions as to what occurs in other spectral regions. Experience has taught radiometricians that the only way to be certain of one's results is to examine the spectrum from wave-length to wave-length throughout the whole range. As applied to incandescent lamps (Hyde, Cady and Middlekauff, *Elec. World*, 53, 1909; *Illum. Eng.*, March, 1909), there is no objection because the energy supplied is dissipated in three important ways, viz., by convection, by conduction (through the lead wires), and by radiation, and since the first two losses cannot explain the difference in light efficiency of two lamps, set to a colour match, about the only conclusion one can arrive at is that the lamp requiring the greater energy input loses the more by radiation in the infra-red.

the area of the prism face exposed to radiation from different filaments. Not knowing the emissivity this would be an unsatisfactory method. A spectrophotometer or optical pyrometer should therefore be employed to set the lamps in the same emissivity at, for example, ·6 μ. Since the eye is the most sensitive for the region at about ·55 μ, where the spectral energy is very weak, it was deemed sufficiently accurate to rate the lamps, as was previously done, by matching them in colour, and then compare the ratios of intensities bolometrically in different parts of the spectrum. If the colour match indicates the true energy distribution, then the ratios of the emissivities of the two filaments should be the same throughout the visible spectrum. With an improved and highly sensitive bolometer it was possible to explore the visible spectrum, which was not done in the previous work, and in three series of observations, as will be shown presently, the ratios indicate (from their rapid increase in value) that at ·75 μ the eye is not able to detect a difference in intensity amounting to about 5 per cent. This would seem to indicate that, in addition to being mere guess work in predicting conditions in the infra-red (for it cannot tell us the manner of energy distribution), the colour match is not very applicable to the visible spectrum. As applied to incandescent lamps, it is less hazardous to use the colour match in predicting the infra-red emissivity of various lamps, because of what is known from other investigations. Without a wattmeter (or calorimeter), however, the colour match tells us nothing, and with it, matters are just about where they were before, as regards our knowledge of the emission of incandescent filaments in the infra-red. The majority of the metals have about the same reflectivity in the infra-red, beyond 1·5 μ, hence their emissivity must be about the same in the infra-red, at the same temperature. On the other hand, their reflectivity is very different in the visible spectrum, and consequently their emissivity must be very different in this region of the spectrum, when operated at the same temperature. Hence, on a colour match, two metals are not very likely to be at the same temperature. The difference in emissivity in the infra-red, of two metals operated on a colour match, will depend principally upon the difference in reflectivity in the visible spectrum. It might, therefore, have been better to set the two filaments to the same emissivity, bolometrically, in the infra-red, and observe their difference in emissivity in the visible spectrum instead of the reverse process herewith presented. The filaments (if metals) would then be operating at more nearly the same temperature than on a colour match. The luminous efficiency would then be obtained at more nearly the same temperature, which is an important desideratum. Instead of a spectrobolometer for making this intensity match in the infra-red it may be possible to use a screen which has a narrow transmission or reflection band in the infra-red, but is opaque to the visible spectrum.

In view of the great importance attributed to the so-called selective emission of the metal filament lamps in the infra-red it is worth while to discuss some recent data on this subject, before describing the present results.

Nyswander* has published a series of spectral energy curves of an incandescent tungsten filament which apparently indicates bands of selective emission in the infra-red, but which in reality are due to atmospheric absorption bands, and also to probable inaccuracies in the so-called slit width correction which is difficult to determine at 1·7 μ, in fluorite prisms. In his earlier work the writer experienced the same difficulties; but after eliminating them, the spectral energy curves of a uniformly heated cavity, as well as those of metal filaments, always were found to be smooth and continuous, except at 3·1 μ, which band seems to be due to atmospheric oxygen. From this, and from our knowledge of the reflecting power of metals, it seems quite certain that in pure metals the spectral radiation curves do not show

* Nyswander, *Phys. Rev.*, 28, p. 438, 1909.

indentations due to bands of selective emission. Instead of indentations, the emissivity of the metal filaments is greatly and uniformly suppressed in the infra-red, as compared with a complete radiator. (See Fig. 1.)

In the present investigation the carbon and tungsten lamps were used. The adjustments and procedure in the experiments were the same as in the previous paper, but a more sensitive bolometer was introduced; and the prism was covered with a diaphragm having an opening 8 mm. wide to insure that, whatever the adjustments in the lamps, the same area of

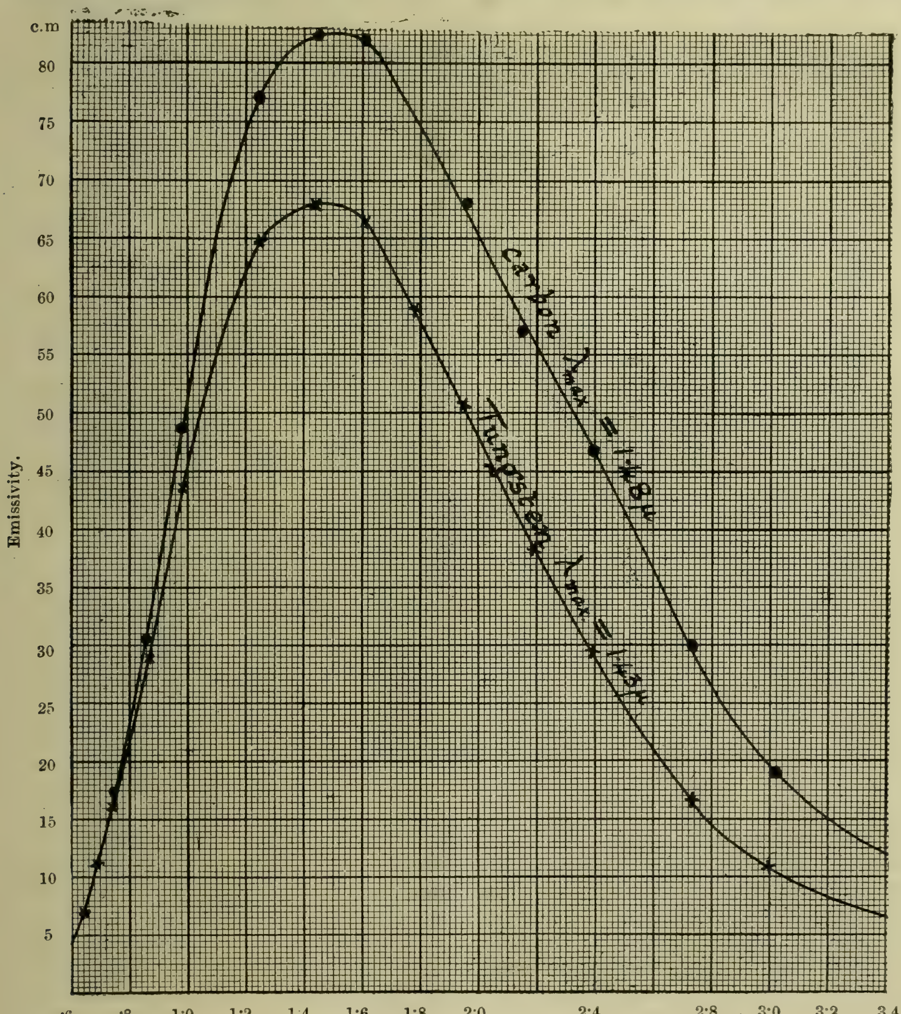

Fig. 1.—Spectral Energy Curves.

matched in colour by several observers, and hence considerable accuracy can be claimed for it. The treated carbon filament was of the single loop type, while the tungsten filament was a single loop "series lamp." To attain greater accuracy straight filaments should be used. ... prism face was covered by the two filaments. In this manner it was hoped that in varying the adjustments, the same ratios of intensities would be maintained, after correcting for variation in sensibility of the bolometer. But the curvature of the carbon fila-

ment did not admit uniform illumination of the prism face, so that while the ratios for various adjustments, gave parallel curves (Fig. 2, *a* and *b*), an additional factor would have to be introduced in order to superpose the two curves. This, however, has nothing to do with the present question of the rapid increase in the ratios as we leave the visible spectrum.

In Fig. 1 are given the spectral distribution of energy of a treated carbon and a "series" tungsten lamp,

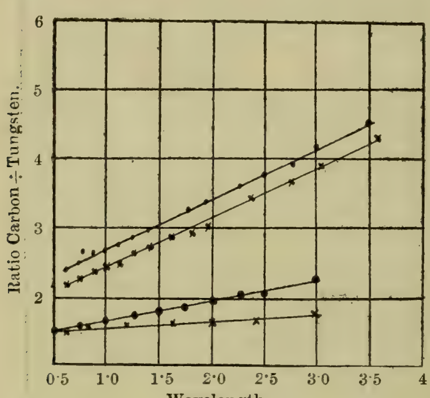

FIG. 2.—Ratios of Spectral Emissivities, Carbon ÷ Tungsten.

having filaments of about the same diameter. The wave-length of maximum emission of the carbon lamp was λ *max* = 1·48 μ, and of tungsten lamp was λ *max.* = 1·43 μ. Beyond 2·5 μ the curves are not comparable on account of the absorption of the glass bulbs. The observations on the tungsten lamp were multiplied by a common factor, which reduced the intensities to equality at ·58 μ. Here the deflections are small and while the errors of observations are large, the effect is insignificant in the energy curve. At ·75 μ the energy curves already depart from equality by about 5 per cent. Here the errors of observation are small because of the large deflections which are at least 5 times those of ·58 μ. In three series of measurements made on different carbon lamps, the energy curves showed an abnormal rise in value at ·75 μ. This rise in emissivity is similar to the spectrophotometric observations of Nichols,* but whether it is a reality would require further investigation. This should be done using a larger dispersion since the radiometric observations can be made with considerable accuracy in this region, where the spectrophotometer becomes untrustworthy.

In Fig. 2 are given the observed ratios of the emissivities of these two lamps. It will be noticed that at ·75 μ the ratios deviate from the general series by a greater amount than can be attributed to experimental error. The two upper curves, Fig. 2, give the ratios of the emissivities (carbon ÷ tungsten) for a colour match when the carbon lamp was operated on about 4 watts p.m.s.c. The lower curves are similar observations made at an earlier date, when the colour match was less accurately determined, and the energy input was different.

The two upper curves are parallel, as they should be, since all the conditions remained the same except that the lamps were readjusted before the slit in the two series. That these two curves do not coincide is due to lack of uniform illumination of the prism in the two series as explained on a previous page. If the colour match gives us an accurate knowledge of conditions then the bolometrically observed radiation curves of the visible spectrum should be parallel, but not necessarily of equal intensity. The ratio of intensities should, therefore, be the same throughout the visible spectrum, *i.e*, the curves should not slope. The curves herewith presented demonstrate conclusively that for a colour match (and intensity match at 0·52 μ), the bolometer shows a difference amounting to 3 to 5 per cent. at ·70 to ·75 μ. The farther the observations extend into the infra-red the greater the ratio of emissivities (carbon ÷ tungsten), and whatever doubts we have regarding the accuracy of the observations in the visible spectrum from the observations at 0·8 μ, there can be no doubt that the eye is incapable of distinguishing variations in emissivity in the deep red, when two lamps are apparently matched in colour.

* Nichols, *Phys. Rev.*, 13, p. 65, 1901.

Modern Methods of Illumination.

Lecture delivered at London Institution on November 22nd, 1909. Abbreviated.

On Monday, November 22nd, a lecture on the above subject was delivered at the London Institution by Mr. Leon Gaster.

In the early part of his discourse the lecturer dwelt on some interesting historical aspects of lighting, narrating how, before the streets of London were adequately illuminated, they were regarded as unsafe by night, and how the spread of better methods of illumination had done much to promote law and order in all big cities.

The spread of printed matter and the development of lighting of dwelling houses had enabled us to do much more work, and, incidentally, led us to tax our eyes to a greater extent than in the past. The phrase "the night when no man can work" had a very real significance in those days, which it had lost now. At the present time, when so many new illuminants were springing up, it was necessary to bear in mind the changing conditions and make sure that our new lamps were wisely employed. Otherwise their coming might, in some respects, prove more harmful than beneficial.

The lecturer next turned to electric lighting, and spoke of the immense development of the metallic filament lamp, its advantages to the consumer and its present drawbacks. He made special reference to the need for a standard specification with which lamps of good quality ought to comply. All lamps passing this test ought to be hall-marked. This recommendation had been expressed by the lecturer in an article which appeared in *The Times* Engineering Supplement of October 25th, 1905, and a very considerable correspondence ensued, in which almost all expressed approval of the idea.

One result of the absence of such a specification and trade mark was that unscrupulous people might occasionally delude the public by selling inferior, but cheap metallic or even overrun carbon filament lamps, which to the non-technical were indistinguishable from good varieties.

In this connexion the lecturer referred to the first Ordinance of the Wax-chandlers issued in the fourteenth century, when the mayor, aldermen, and sheriffs of London were petitioned by the people of the city to frame regulations in order to prevent the issue of candles of poor and adulterated quality. To this end they directed that a committee of inquiry of "four lawful folks of the said trade" should be formed, and that a certified trade-mark should be stamped on all genuine goods. This, he thought, was an instructive precedent, and it was also interesting as showing the feeling for the need of a central lighting authority in London, even in those old and simple days. How much greater this need to-day when so many different competing illuminants were available!

The lecturer next turned to gas lighting, and described the development of the inverted mantle, of high pressure gas lighting, and methods of automatic ignition and extinction. All this was illustrated by specimens of the most recent types of lamps and accessories. He spoke in some detail of the recent deputation of the Corporation of London who had paid a visit to the Continent to study methods of street lighting. This, he said, was an interesting example of the growing recognition of the importance of illumination from the civic standpoint, but he thought that the report of the Corporation would have been even more instructive had they followed the example of their predecessors in the fourteenth century, and made more use of expert advice without which

non-technical observations were naturally of limited value.

He himself had recently paid a visit to Germany for the same purpose and had seen, in Stuttgart, the new method of suspending gas lamps on wires spanning the street which the Corporation recommended. Some lantern slides showing this arrangement were exhibited. The lecturer added that the report of the deputation stated that further experiments were to be conducted in the streets of London. He felt, however, that any such experiments, to be conclusive, ought to be conducted by recognised experts on strictly impartial lines, and, above all, with the object of answering some definite enquiry; many experiments of the past had proved of little value because of vagueness as to their exact object.

Other systems of lighting them came in for some consideration, and specimens of incandescent oil-lighting, acetylene, and petrol-air gas installations were exhibited. The latter method involved the production of a mixture of petrol-gas and air, but a very small percentage of petrol-vapour being needed.

In the last part of his lecture Mr. Gaster dealt with many important questions, such as street-lighting and the illumination of schools, factories, libraries, hospitals, museums, &c. All these, he said, presented difficult problems on which further knowledge was wanted; it was, moreover, a matter of more than national importance for the children of our schools to work under proper illumination. Otherwise, medical authorities agreed, their eyes and health were bound to suffer.

One matter on which Mr. Gaster dwelt with special emphasis was the importance of keeping the modern brilliant sources of light out of the direct range of sight, so as to avoid anything in the nature of a glare.

In conclusion, the lecturer pointed out that all he had said had been intended to show the vast field for study in the subject of illumination and the need for some impartial authority to deal with these important matters.

With the object of promoting the much to be desired free and impartial expression and discussion of these problems, the Illuminating Engineering Society had this year been founded in London. Besides promoting such discussion at their meetings, the Society aimed at educating and helping the general public and also the large number of people who, in one respect or another, were engaged in the business of supplying and directing the use of light. The Society, therefore, would hold out a hand to all interested and would tend to promote better understandings between consumer and supply company, and to remove much of the misunderstandings of the past. A special feature of the programme of the Society was its international connection.

The lecturer pointed out, further, that the movement was in harmony with the tendency of many firms to deal with all kinds of illuminating apparatus. For example, the Welsbach Company in this country had just decided to supply electric lamps. Again there were a number of Corporations which were interested both in the supply of gas and electricity, and many contractors were interested in both gas and electric lighting, and ought, therefore, to welcome the coming of the new society.

Mr. Gaster closed his lecture by referring to the Inaugural meeting of the Society, which took place on Thursday, November 18th, when Professor Silvanus Thompson, D.Sc., F.R.S. delivered his Presidential Address, and expressed the conviction that much good would follow from the co-operation between the engineering, medical, and architectural professions which, it was hoped, the Society would be instrumental in bringing about.

Factory Lighting.

By L. B. Marks.

(*Continued from p.* 758.)

A paper presented at the Third Annual Convention of the Illuminating Engineering Society, New York, September 27, 28, 29, 1909; abbreviated.

Illumination Measurements, Factory D.

Test of efficiency of reflectors. Typical 5 in. by 10 in. cone-shaped metal reflector, equipped with 16 candle-power Edison 220-volt lamp. Test plate of photometer 1 ft. 8 in. below lamp. Same lamp used in the three tests.

Foot-Candles (Horizontal Illumination).

Reflector having clean inside surface	30·0
Reflector having finger marks on lower inside surface	23·5
Reflector, oil spattered and deteriorated	16 8

Discussion of the Illumination Measurements, Factory D.

Building No. 17, Second Floor.

Mill Miscellaneous Department.—Attention is called to the fact that although the daylight illumination on the drill press about midway between the windows on either side of the building was only 4·6 foot-candles, this amount of light was sufficient for the work. In the same location at night the localized illumination on the machine directly underneath the drop lamp was several times as much as the illumination in daylight. No foot-candle reading of the night illumination in this location was made, as the conditions were practically the same as those that were obtained in some other parts of the shop where readings were taken at night.

In the straightening department the amount of light (400 foot-candles) which meets the eye of the operator when he performs the straightening operation by natural light, is more than 65 times as great as that which meets his eye when the operation is performed by artificial light exclusively. In the day-time the operator faces an unscreened window at close range. His eyes are not protected from the enormous flux of light through the window, with the result that not only does his eye-sight suffer, but the pupil of his eye is automatically stopped down to such a degree that the actual amount of light that is useful for vision is only a small fraction of the total amount of light that is useful for vision is only a small fraction of the total amount of light on his work. With a lower intensity of daylight illumination the operator would undoubtedly be able to see better, especially if the eye were shielded from the direct light of the window.

Third Floor.

Parts Assembly Department. — At night the illumination on the bench is about 6½ times as much as that which was considered satisfactory in daylight illumination.

Fourth Floor.

Segment Department.—Note the low value of the daylight illumination (3·1 foot-candles) at the grinding machine near the centre of the room. This comparatively low intensity of illumination was considered satisfactory.

Tool Department.—The daylight illumination (3 foot-candles) on the milling machine near the centre of the room is sufficient in this edpartment except for very exacting work. Note that the night illumination on the same machine is 20 times as much as the day illumination.

The intensity of the general illumination (14/100 of a foot-candle) of the

room at night with all of the lights in operation, is extremely small. This low value is characteristic of the intensity of the general lighting of all the floors of the factory, with the exception of those lighted by the Cooper-Hewitt lamps.

BUILDING NO. 1.—SECOND FLOOR.

Manager's Office.—The illumination at night (2·1 foot-candles) on the table in the Manager's office was sufficient for reading fine print with ease. The location at which the measurement was made was about 12 ft. from the three-light ceiling cluster which furnished the illumination of the room.

THIRD FLOOR.

Mill Iron Department. — At the machine near the centre of the room the localized illumination produced by the drop lamp at night was more than ten times the amount of daylight illumination which the foreman of this department considered satisfactory for the work.

BUILDING NO. 13.—THIRD FLOOR.

Screw Machine Department.—The intensity of localized illumination (133 foot-candles) on the automatic screw machine was at least 20 to 25 times the intensity of lighting best suited for this work. The highly concentrated light at the spindle of this machine has a blinding effect on the eyes of the operator.

FOURTH FLOOR.

Aligning Department.—Mercury arc lamps are used for the illumination of this department. Measurements were made to ascertain the maximum and the minimum horizontal illumination on the aligners' tables. The foot-candle values obtained serve to show the maximum and the minimum illumination under daylight conditions and at night, at distances respectively 6 ft. 6 in. from the window and 11 ft. 6 in. from the window. The minimum illumination at night (30 foot-candles) is excessive, and is probably at least three times the intensity that would be required under conditions of good diffusion of light and suitable screening of the lighting sources. As at present used the lamps are unshaded, and their intrinsic brilliancy although not of a high order, is sufficiently large in amount to considerably stop-down the aperture of the eye, as the lights are hung low and are all within the ordinary field of vision of the operators. The proximity of the lamps to the work and the absence of suitable diffusing shades and screens combine to produce glare and to reduce visual acuity. There is very considerable direct (harmful) reflection of light from the typewriting machines on the aligners' tables.

It is believed that if the lamps are equipped with suitable diffusing shades and screens and relocated, the objections above cited may be largely, if not entirely, overcome.

JAPAN BUILDING.—THIRD FLOOR.

Striping Department.—At the time the measurements of daylight illumination were made, direct sunlight entered some of the windows at the stripers' benches. One window shade had been lowered by a striper who preferred to work in subdued light. The shade at the window immediately adjacent had not been lowered, the striper preferring to work in direct sunlight. The foreman of the department stated that the conditions of illumination at the time the measurement was made were normal.

The measurements show that the intensity of illumination on the work of one operator was about 25 times that on the work of his neighbour. There can be no doubt that the presence of a brilliantly illuminated zone in the immediate vicinity and in the field of vision of an operator who is working with a low intensity of light on his work, is very trying to his eyes, to say nothing of the eyes of the operator who is performing his work in the brilliantly illuminated zone. With such lighting conditions neither operator can do his work to the best advantage.

Provision can be made by means of suitable shades to secure moderate intensity and comparative uniformity of illumination on the stripers' benches. If the matter of adjustment of these shades were suitably controlled, violent contrasts of illumination might easily

be avoided. With these improvements instituted, the stripers would undoubtedly be enabled to do better and quicker work.

Two drop lights are used to illuminate the work of each striper at night. The intensity of illumination on the work is excessive. The data in the table sho wthat the night illumination on the work of one of the stripers was over 7 times the illumination which he considered satisfactory in the daytime.

Discussion of the Illumination Measurements, Factory "E."

FIRST FLOOR :

North Room :—It will be noted that the amount of illumination at the ribbon inking machines at night was 8 foot-candles. The method of illuminating these machines combines both general and local illumination. The local lighting, even though the lamps are 7 ft. from the floor, is fairly concentrated, and the position of the lamps with reference to the machine is such that some of the working parts of the machine are in shadow. Thus, for example, the illumination of that portion of the machine directly beneath the ink pans was found to be only 0·39 of a foot-candle.

Comparing the illumination at night with that in the daytime at the same place, the measurements show that the daylight illumination on a bright afternoon at 5·00 o'clock was only 8 foot-candles, or precisely equal to the amount of illumination at this location at night. It should be borne in mind that the daylight illumination represents the general illumination at the machine, whereas the night illumination in this case represents the light on only a very small portion of the machine. It is clear that the unsatisfactory result in the lighting of these machines by the present method is not due to the lack of intensity of illumination. The intensity of illumination was no greater in the daytime when the machine was very satisfactorily lighted than it was at night when the machine was unsatisfactorily lighted ; in fact, even at a very considerably lower intensity of illumination in the daytime (5·6 foot-candles), there was adequate illumination. The data obtained in the daylight measurements indicate that if the artificial illumination could be effected by well diffused lighting, good results could be obtained at an illumination intensity considerably less than 5 foot-candles.

South Room :—The carbon coating machines are illuminated by arc lamps. The measurements show that the amount of illumination at night on the rear portions of the machine is less than one-quarter of that on the front of the machine. The data also show that there is a very considerable variation, amounting to about 20 per cent, in the periodic intensity of the light of the arc lamps.

Second Floor :—The measurements show that the general illumination on the carbon paper inspecting table at night was 6 foot-candles as compared with 40 foot-candles in the daytime. On account of the colour of the work (black paper) a high degree of intensity of illumination is required in this department.

Résumé and Conclusions.

The system of localized and highly concentrated illumination as commonly used in many factories of which the above are typical, is open to the following objections :—

1. The illumination produced by each lamp is confined to a very small zone which is brilliantly illuminated, while contiguous parts of the working space where good light is needed, are in comparative darkness. The actual intensity of illumination directly underneath the lamps is in most cases several times as much (often from five to ten times as much) as is desirable to secure the best vision.

In general it may be stated that when artificial illumination is properly applied the amount of light needed to see well at night is only a small fraction of the amount of light usually supplied in daylight illumination.

2. With the localized system of illumination as installed in these

factories, there is a maximum of direct (harmful) reflection of light from the working parts of the machines. Owing to the location of the lighting source with reference to the object illuminated, a considerable percentage of light from the lamp is reflected directly from the work to the eye of the operator. The direct reflected light does not increase the ability of the operator to see the object but on the contrary, decreases his visual acuity and necessitates the use of a far greater amount of localized light than would be needed if there were no direct reflection. Measurements made at the factories and cited in the table above showed excessive direct reflection of light especially from the type-writing machines in the aligning department. The illumination measurement at one of these machines showed that fully 10 per cent of the incident light was directly reflected from the machine into the eyes of the operator. This abnormal reflection (glare) reacts on the eyes of the operator and albeit the high intensity of concentrated light on these machines, accounts in a large measure for the complaints of inadequate illumination in the aligners' department.

3. In a system of localized illumination such as is employed in these factories, it is necessary to frequently readjust the height and position of the lamps to suit the requirements of the work. The drop lamps are necessarily placed quite close to the work. Each operator adjusts the position of his lamps close enough to his work to give an illumination which is satisfactory to him. As a result of this practice it sometimes happens that the operator, in order to secure suitable illumination on his work, may so adjust his lamp that part or all of the light therefrom shines directly into the eyes of his neighboup.

There appears to be a natural tendency on the part of the operator to place his lamp as close as possible to the field which is to be illuminated. The operator may be content for a while with the localized lamp 2 feet or even 3 feet above his work, but experience shows that when the matter of adjustment is left to him, he will as a rule, ultimately lower the lamp to a position as close to the work as it is possible to locate the lamp without actual physical interference with the operation of the machine or the performance of the work.

4. The frequent handling of the lights by the operators to adjust the height and position of the lighting units, results in soiling the lamps and reflectors. It is not unusual, in most of the departments, to find finger marks, on the glass bulbs and on the reflecting surface of the shades, which latter are in many instances so smutted from handling that they are practically worthless as reflectors. The proximity of the lamps and reflectors to the machines accounts in some cases for the rapid accumulation of gritty and oily material on the former. This is especially true of the grinding, the buffing and the automatic screw machine departments, in which the lamps and reflectors are begrimed and oil-spattered. The measurements given in the tables show that almost double the amount of light was given on the working plane when a clean reflector was substituted for a deteriorated reflector.

The handling of the lights by the operators and the disposition of the latter to place the lamps as close as possible to the work, sometimes leads the operators to bend the reflectors and force them into some convenient part of the machine close to the work. In some instances where it is impossible to lodge the light in a convenient part of the machine because of the large size of the reflector, the reflector is removed by the operator and the bare lamp used.

5. The frequent adjustments and re-adjustments of the lights unnecessarily occupy the time of the operator and to some extent distract his attention from his work.

6. The multiplicity of dangling wires from the drop lamps presents an unsightly appearance. Moreover, those wires are apt to be in the way of moving parts of the machinery, &c.

7. In some cases the eyes of the

COMPARISON OF ILLUMINATION MEASUREMENTS IN FACTORIES "A," "B," "C," AND "D."
(Foot-candles, horizontal illumination except where otherwise specified).

Factory	Inspection Dept. (On inspector's table)		Aligning Dept. (on aligner's table)		Japan Dept. (On striper's bench)		Straightening Dept. Vertical illumination)		Automatic Screw Machine Dept. (On machine)		Milling Dept. (On Milling machine)	
	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day
"A"	20·5	55·	25·7	150·	36·				8·9 to 15·	2· to 3·1		
"B"	45·	85·	50·	62·5					19·5	2·5	42·5	4·4
"C"	55·	58·	250· (maximum)	65·	50·	37·5	7·	6·5 to 8·			76·	8· to 17·
"D"	79·	12·	30· to 40·	47· to 87·	150·	21· to 500·	6·	400·	133·	37·	60·	3·

operator are very close to the reflector and are affected by the heat of the lamp.

8. Objectionable shadows are cast by the reflectors, lamps supports, drop-cords, and hangers.

9. The shops present a gloomy appearance at night. Even when all of the local lamps are in operation, the intensity of the general illumination on the working plane in locations outside of the restricted field illuminated by the drop lamps, is at best only about a quarter of a foot-candle, being less than one-seventh of a foot-candle in most of the departments, and in some less than one-thirtieth of a foot-candle, as shown by the measurements given in the tables.

10. The extremely low degree of general illumination in the shops makes it difficult if not impossible for the foreman to exercise the same character of supervision at night as he does in the daytime, and makes it more difficult to guard against factory accidents.

11. With the present system of localized illumination in the shops, advantage cannot be taken at night of the reflecting and diffusing value of the walls and ceilings, whereas in the daytime the walls and ceilings are used to great advantage in reflecting and diffusing natural illumination.

In the last table of illumination measurements the actual amount of light used under practical working conditions both by daylight and by artificial light for the same class of work in factories A, B, C, and D is given. These comparative measurements which have already been discussed in detail herein, are selected from a large number of tests made in the several factories. The comparison shows,

1. That the intensity of artificial illumination is excessive and is in many cases greater (in some cases from 10 to 20 times) than the intensity of the natural illumination that is adequate for the same work.

2. There is a wide variation, amounting in some cases to several hundred per cent, in the intensity of artificial illumination for the same class of work in the various factories.

The remedy for very many of the foregoing objectionable features lies in the introduction of suitable general illumination, proper location of the lamps, reduction of intrinsic brightness of the light sources, improved diffusion and direction of light, introduction of lights of suitable colour-value, and moderation of intensity of illumination suggested in the body of the paper.

An Interesting New Type of Illuminated Sign.

In a recent number of the *Oesterreichischer-Ungar. Installateur* mention is made of a new type of illuminated sign now in use in Paris which is apparently exceptionally simple and ingenious in action.

A large sheet of opal glass is illuminated strongly from behind by a series of electric glow-lamps; this sheet of glass is covered with an adhesive coating of black varnish, which, however, can be easily scratched away by a sharp-pointed implement. An operator standing unseen behind the screen can thus readily write up any desired motto, which appears to spectators in the street as if written in fire on a dark background by an invisible hand. By giving a new coating of black paint the sign can be used *de novo*, and any number of inscriptions written up in succession, and subsequently removed.

Education from the Illuminating Engineering Standpoint.

By F. K. Richtmyer.

(A paper presented at the Third Annual Convention of the Illuminating Engineering Society, New York, Sept. 27, 28, 29, 1909. Abbreviated.)

It would be presumptuous to regard the very rapid development of illuminating engineering as a separate entity in the great science of engineering in general. Thanks to this society and its promoters, far more attention is now being given to the proper lighting of our factories, public places, and homes than ever before. We are beginning to see the need of consulting a specialist in this line just as we employ an architect to design a building or a civil engineer to lay out a railroad. In other words the illuminating engineer has taken his place in the commercial world and his development and education must be seriously considered whether we are to leave his training to the field of commercial enterprise, as has been done heretofore, or to establish special courses in the engineering schools to meet his needs. Or what amounts to the same thing : do the present courses in electrical and mechanical engineering furnish adequate ground work on which, after graduation, the student may build in the school of practical experience ? If not, what additional instruction should be given and how should the new courses be correlated with the old ? These are questions which must be answered, directly or indirectly, by such interests as this society represents. If there is a demand, the universities will not be slow to furnish the desired instruction.

That it would be advantageous to the illuminating engineer to have his work represented in the technical schools and colleges can hardly be doubted, judging from the experience of the other great branches of engineering. The extent to which the student should specialize in such subjects as photometry, gas analysis, lamp design and manufacture, and the like, are questions which have their parallel in all technical schools, many competent engineers insisting that *all* specialization should be left to field work after the general training given by the technical schools is finished.

However that may be, it must remembered that the furnishing instruction is only one of the duties of our universities ; the other duty, perhaps quite as important, is the doing of research work. Such research as is now being done in illuminating engineering is carried on, or at least entirely stimulated, by commercial interests, and while the records of this society show that remarkable progress has been made, yet from the very nature of the work many problems, not distinctly commercial but of much theoretical importance, have been left untouched. Here lies the work of the university.

A cursory examination of the courses offered in a number of our leading universities, however, fails to reveal any that are devoted exclusively to practice in *photometrical measurement* although some lecture work of a descriptive and historical nature is given. Such instruction as is offered is usually found in connection with laboratory courses in physics or electrical engineering. But even here the photometrical measurements are only secondary, the main point of the experiment being usually the study of some problem by the aid of photometry. At any rate the writer has not found a course in photometry sufficiently abbreviated for the already over-full curriculum of our engineering schools, and yet so arranged as to give a working knowledge of the subject. Thus as there is no precedent to adopt, the author therefore gives the

accompanying list of experiments, which will be adopted in the coming year.

The maximum time in the laboratory available for students who may take the course, will be one three-hour period per week for one year—approximately 30 periods. About the same amount of time will be spent outside the laboratory.

A List of Experiments in Photometry.

Exp. 1. A study of simple photometers (Bunsen and Lummer-Brodhun) and calibration of a working incandescent standard (*a*) from the Hefner lamp and (*b*) from master incandescent standards. Also the use of screens.

Exp. 2. Calibration of the Weber photometer as a candle-power measuring instrument by use of the above working standard, using a miniature tungsten lamp as the comparsion source in the Weber.

Exp. 3. Measurement of distribution of light around an incandescent lamp, including the determination of mean horizontal and of mean spherical candle - power. Lummer - Brodhum Photometer.

Exp. 4. Characteristic curves and efficiencies of the several kinds of incandescent lamps, using the Weber photometer.

Exp. 5. Study of several gas lights, both flame and mantle, for varying pressure. This includes distribution cruves, intrinsic brightness, gas consumption, and errors due to colour differences in the photometer field.

Exp. 6. Effect of globes and reflectors on light distribution around several sources.

Exp. 7. Calibration of the Weber photometer as an illuminometer, including variation of the test plate from the cosine law, variation of photometer tube from the inverse square law, coefficients of the several plates of the photometer, &c.

Exp. 8. Measurement of distribution of illumination and efficiency of installation in a lighted room for several arrangements of lamps, reflectors and walls. Also the plotting of equilucial lines by the several methods.

Following, this if time permits, may be given such work as the study of various photometers and their errors, measurements of coefficients of reflection, or other problems that may come up.

In preparing this outline no attempt has been made to include all that the student should know about photometry. For example, nothing has been said about the calibration and the desired accuracy of the necessary electrical instruments. But it is assumed that after completing the above experiments the student would know better than to use a pocket voltmeter on a working standard. By studying the most important photometrical principles and units, and by extended practice with at least one photometer—the Weber—the student will be able to solve other difficulties as they may arise.

Cornell University,
September, 1909.

Illuminating Engineering and Ophthalmology.

By invitation, Mr. L. B. Marks last week addressed the annual meeting in New York of the American Academy of Ophthalmology, the members of which include the leading oculists of the United States. In his address Mr. Marks made a plea for co-operation between the illuminating engineer and the oculists, and the Academy will probably take some action in the matter.—From *The Electrical World*, New York, October 14th, 1909.

REVIEWS, ABSTRACTS, AND REPRODUCTIONS.

The Present Aspect of Electric Lighting.

By H. W. Handcock and A. H. Dykes, Members.

(Abstract of Paper read before the Institution of Electrical Engineers, London, November 25, 1900.)

When we wrote our paper on 'Electricity Supply and Metallic Filament Lamps,' which was read before the Institution in April, 1908, the wire lamp had but recently appeared on the horizon, and there was general uncertainty as to what was likely to be its effect on the electric lighting industry.

Two years have elapsed since the paper was written, and it may be of interest to members to review the position to-day to see what the actual effects of the introduction of wire lamps have so far been, whether the fears expressed by some have been justified, and whether new factors are being introduced which may tend still further to modify the previous condition of affairs.

The first thing that strikes one is the extraordinary progress made by the lamp makers in the interval.

The manufacturing difficulties which led to blackening and premature failure have been almost entirely overcome, the methods of attachment and of supporting the filaments have been improved, and apart from mechanical damage, the useful life of the lamps has now been proved to be, on an average, about double that of carbon filament lamps. It is not always easy to get exact figures as to the life of lamps under ordinary working conditions subject to the variations in voltage which occur to public supply mains; however, several instances of lamps having lasted for over 1,200 hours may be quoted.

The price of wire lamps has also been reduced and the 100-volt 25-c.-p. lamp which two years ago cost 4*s*. is now listed at 3*s*. Having regard to the longer life of the new lamps, they are thus but little more expensive than carbon lamps, a fact which cannot fail to accelerate their adoption.

Two years ago the best that a consumer on a 100-volt circuit could do was to replace an 8-c.-p. 33-watt carbon lamp with a 25-c.-p. wire lamp taking about the same amount of energy and costing 4*s*. each.

To-day he can—if he wishes—replace the 8-c.-p. 33-watt carbon lamp by a 14-c.-p. wire lamp, taking only half the energy and costing 2*s*. 9*d*.

It is evident that whatever has been the effect of the wire lamp on supply stations during the last two years, it will be greatly intensified in the near future.

The results of the past two years have only served to strengthen the authors' belief that the flat rate system fails to meet the conditions that now obtain, and that only by the adoption of some system which secures to the undertaking a definite minimum return from each consumer based on the rate at which he contracts to take energy can purely lighting stations be profitably run.

There is probably scarcely a single alternating-current station supplying a purely lighting load which has, within the past year, sensibly increased its output, although it may have considerably increased its lamp connections, except possibly in the case of those in competition with a direct-current station in the same area.

Experience has shown that on the average consumers have reduced their consumption even where they have somewhat increased their illumination, and the revenue received by the station per lamp connected has consequently fallen very considerably.

It is, of course, early days to judge of the effect, but the results up to date are instructive. In the case of those consumers who have taken advantage of the new arrangement it is found that formerly their lamps averaged 12 c.-p. and their consumption per lamp installed was 15·6 units per annum.

As a result, in spite of the wiring rental being increased, and in spite of an increase in the illumination of 33 per cent., the inclusive receipts per lamp have fallen from 7*s*. 9*d*. to 6*s*. 4*d*.

It will be noted that in most cases a 25-c.-p. 30-watt metallic filament lamp will satisfactorily replace an ordinary gas burner such as is normally in use. It is

true that with a photometer a mantle when new will, under certain conditions, show possibly 60 c.-p., nevertheless experience shows that with few exceptions the average man is quite satisfied with the 25-c.-p. metallic filament lamp for indoor domestic purposes.

The cost of lighting is judged by the every-day user, not by the nominal candle-power of the illuminant, but by the total cost of obtaining a satisfactory effect in a room. If, for instance, a 25-c.-p. lamp lights a room adequately for a given sum per annum, a consumer would not thank you for saying to him, "I cannot give you a steady 25-c.-p. lamp for that sum, but for a somewhat higher figure I will give you a gas lamp fluctuating from 60 c.-p. downwards."

For domestic purposes the 25-c.-p. electric lamp is a satisfactory unit of illumination, and if it is more economical than the so-called 60-c.-p. gas-light, the consumer will take it. Given a proper method of charging, we are of opinion that not only can this be done, but in such a way as to prove very remunerative to the electric light undertaking.

With the flat-rate system of charging the long-hour consumer at present uses gas. One reason for this is that, owing to the loss made by the electric light undertaking on the short-hour consumer it is necessary to keep up the price all round, and the competitive illuminant benefits.

One frequently speaks as though it were an absolute necessity to supply every consumer in an area, regardless of whether he be profitable or not; yet the very short-hour consumer, from the nature of the problem, can never be a remunerative one to an electric light undertaking on the present flat rates, as the capital outlay to supply him is very nearly the same as for a long-hour consumer.

Let, therefore, such a consumer go if he will not pay his fair contribution to the cost of supplying him; let him use gas or candles, and let us concentrate our efforts on the long-hour man who gives us a greater number of working hours over which to earn interest on our capital.

At the moment it is generally the other way round, and electricity is given the unremunerative short-hour lamps *because the present tariffs make the cost of long-hour lamps too high.*

The difference in cost is so little, and the business advantages, from the point of view both of the station and the consumer, of a fixed charge are so great, that it is preferable to make a fixed charge per lamp per annum, irrespective of the number of hours during which the lamps are used.

It obviously does not pay to go to the expense of putting in a meter, providing a staff to read it and keep it in repair, and a staff of clerks to make out the accounts, in order to check such small variations in revenue, more particularly if the relative importance of the standing charges be still further increased by the station supplying the interior wiring.

It may be objected that if there be no meter and no restrictions, the consumer will waste the commodity. If the objection were valid the present system of water supply in London would be an impossibility. It must not be forgotten further that the longer the lamps are used the greater the cost to the consumer of lamp renewals, which thus acts to a certain extent automatically as a check.

As the station is charging per lamp, it must obviously also have some check on the consumer in order that he may not, for instance, substitute a 100-c.-p. lamp for the 25-c.-p. lamp allowed for. We prefer to do this by using special lamp-holders such that only lamps which are sold by the station or its agents can be used. The consumer who comes back too often for lamp renewals will thus be detected and dealt with accordingly if it be found that he is wasting current.

Taking the average life of the lamps at 1,200 hours, they would use in that time, say, 36 units per 25-c.-p. lamp. This at 0·4d. per unit represents 1*s.* 2½*d.*, and where the station sells the lamps, the profit on their sale would to a great extent automatically compensate for the wastefulness of any of its consumers.

It is obvious, therefore, that even with a wasteful consumer the station could not lose much, and a meter can, if desired, be put in to check in special cases any consumers suspected of wilful waste. For the reasons above set forth we believe that all stations having normally low running costs could, with great advantage to themselves, supply the long-hour consumer, who at present generally uses gas, at a fixed charge per lamp per annum, which would be well below what he is at present paying. The price will naturally vary for each district, but a fair average, inclusive of wiring rental, appears to us to be 12*s.* per 30-watt lamp per annum for a continuous supply, and 10*s.* per annum for a "dusk to dawn" supply.

This system we call the "Contract" system, to distinguish it from the Contract Demand system.

The proposal is, of course, by no means new, but it was practically an impossible

one as long as we were restricted to the carbon filament lamps. The introduction of the wire lamp and the great reduction in the running costs during the past few, years have, as we endeavour to show, entirely altered the position.

The Contract system does more than simplify the clerical work of the station. It is one thing to go to a prospective consumer and explain that at the price you are charging electricity is cheaper than gas. In nine cases out of ten he will be sceptical, and will wait until he sees his neighbours' bills before he will come on.

It is quite another matter when you can go to him and say, "Come and look at this room lit electrically; you can have your house lit with the same lamps and can use them as you like for a fixed charge per lamp per annum."

If you can get over the difficulty of the first cost of wiring, you have in all probability secured that man as a consumer.

We are of opinion that in the future puerly lighting stations will, in order to secure the necessary large number of new consumers, be absolutely forced, either directly or through a subsidiary company, to undertake the wiring of houses and to supply lamps—in fact, *to* sell *light*, and not electrical energy.

By this means any improvement in the efficiency of the lamp will be of benefit to the stations and not, as at present, a loss to them. It will be in their interest to do all in their power to encourage the lamp-makers and to seek to give the maximum illumination for the minimum of current.

At present, what do we see? Half the electrical world counting their losses due to an invention which should have proved, and may yet prove, as great a benefit to the industry as it undoubtedly is to the consumer.

To bring this about, however, other innovations must follow the introduction of the wire lamp. Among others, it is all-important that the cost of wiring should be reduced, and as many of the new consumers will have only a few lights, that the cost of services be brought down also.

During the past year or so considerable attention has been given to this problem, and a number of very excellent systems of economical wiring have been launched on the electrical world. They all have their good points, and it is for each engineer to select the one which best meets his requirements.

Whilst in most districts it will pay a man with only a few lights, which he uses in consequence for fairly long hours, to use electricity, the man with fifty lamps might find the same charge too high. Nor, indeed, would it be justified, as we have assumed so far that 80 per cent. of the lights installed are turned on at once, whilst the consumer with a greater number of lamps will probably never use at one time more than a small proportion of his lights, the great majority of which will only be in use for a comparatively short time per annum.

To meet this difficulty, we put in a limit indicator, ask the consumer to switch on the maximum number of lamps he wishes to use at once, and charge him, say, 12*s.* per 30-watt lamp, calculated on the number to which the limit indicator is set, and 2*s.* per lamp on the remainder to cover the wiring charges. He thus settles his own diversity factor and is charged accordingly.

This enables him to put in lamps where he naturally would not use them if he had to pay full price on all lamps, and at the same time obviates the absurdity one so often sees, viz., a station providing capital for free-wired lamps, which do not even pay the annual wiring charges.

Another plan which has been adopted is to charge, say, 10*s.* per lamp for the first five lamps, 8*s.* per lamp per annum for the next five, 7*s.* 6*d.* per lamp per annum for the next ten, and 5*s.* per lamp for all above that number, the exact figures depending on the size of the average installation in the district.

Such a scale is, in most cases, however, not so satisfactory as the first plan, as it assumes that the habits of all consumers having an equal number of lights installed are the same, which is generally far from being the case.

No gas company can afford to lay on gas, make a fixed charge per annum dependent on the number of burners, and allow the consumer to use as much gas as he pleases. We believe that an electric light company can deal with the consumer on this basis and make a profit out of it.

Comparing the present proposals with the conditions obtaining only three years ago, what do we find? The standing charges of the station and mains per unit of candle-power capacity have, by means of the wire lamp, been reduced by nearly two-thirds; by using double-wound transformers interior wiring becomes single wire instead of double; a main cable consisting of a single No. 18 wire can, at 100 volts, supply all installations of twenty 16-c.-p. lamps or under; the old double-pole distribution fuseboard is replaced by a single 5-ampere fuse; the meter becomes a memory of the past.

TRADE NOTES.

[At the request of many of our readers we are extending the space devoted to Trade Notes, and are open to receive for publication particulars of new developments in lamps, fixtures, and all kinds of apparatus connected with illumination.

The contents of these pages, in which is included information supplied by the makers, will, it is hoped, serve as a guide to recent commercial developments, and we welcome the receipt of all *bona fide* information relating thereto.]

Holophane Scientific Glassware.

We have received from the **Holophane Glass Co.** (12, Carteret Street, London, S.W.), copies of the newly issued catalogue of Holophane globes and reflectors. The first portion of this publication deals with the principles underlying this scientific glassware, and is illustrated by diagrams showing how the prisms are effectual in breaking up the light; each point on a diffusing globe thus becomes a separate light centre, from which rays are sent out in all directions. Globes and reflectors are divided into three chief classes A, B, and C, designed to concentrate the light, to distribute it in all directions, or to throw it out sideways respectively.

An important feature of the Holophane reflectors is the use of total internal reflection prisms by means of which the bulk of light can be concentrated downwards; at the same time a small amount is transmitted through the glass and can be utilized to illuminate silk shades, &c., placed thereon. Special reference is made to the low absorption of light by globes of this description; thus one long series of tests at the Massachusetts Institute of Technology showed that closed Holophane globes absorb only about 12·3 per cent. of light. It is also stated that dust deposited on reflectors only affects their efficiency very slightly, and can, in addition, be removed very easily.

In the illustrations on the opposite page some of the most recent types are exhibited. Figs. 1 and 2 refer to the Holophane concentrating reflecting bowls and spheres respectively, and Fig. 3 shows one of the well-known pear-shape pendants. Fig. 4 refers to a concentrating reflector, and Figs. 5 and 6 are special newly-issued patterns of ornamental reflectors of a similar class.

Special attention may be drawn to the combination bracket globe shown in Fig. 7. In this case half of the fixture is designed to reflect and half to refract, so that comparatively little light is lost by being thrown against the wall, the majority being reflected into the room. Finally, Fig. 8 shows a new type of concentrating reflector which is also a recent introduction, the non-prismatic portion of the fixture being either clear or finished in satin as desired.

We note that the engineering data supplied by the company conclude with several important suggestions such as "never to use a pendant globe instead of an upright one"; naturally this would give the reverse of the desired distribution of light; also invariably to employ the lamp recommended for use with given globes or reflectors for which they are specially designed. Finally, we note the instruction, "If there is any doubt as to the proper globes or reflectors for use for any specific purpose, consult us."

Electric Lighting Exhibition at Leicester.

It is always interesting to us to record an instance of co-operation between gas and electric lighting interests, and we are, therefore, very glad to draw attention to the Electrical Exhibition of the Gas and Electric Lighting Department of the Corporation of Leicester, which was opened on November 25th, at the offices of the Corporation at Millstone Lane.

We note that special arrangements were made to show the every-day use of electricity in halls, dining rooms, drawing-rooms, bath-rooms, kitchens, &c., attention being devoted to electric heating apparatus. A lady lecturer gave demonstrations of cooking, ironing, and other processes carried out by electricity.

Full particulars can be obtained from Mr. Alfred Colson, M.Inst.E.E., Engineer and Manager.

Fig. 1.

Fig. 2.

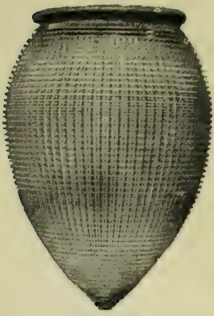

Fig. 3.
Pear - shaped
Diffusing Globe.

Fig. 4.

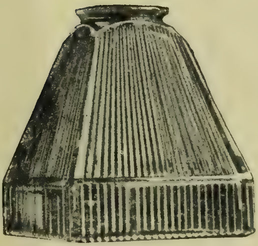

Fig. 5.

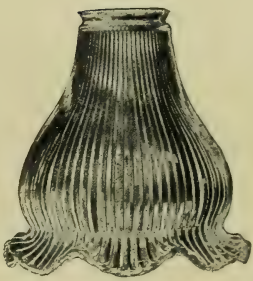

Fig. 6.

New Types of Reflectors.

Fig. 7.
Combination Upright Fixture.

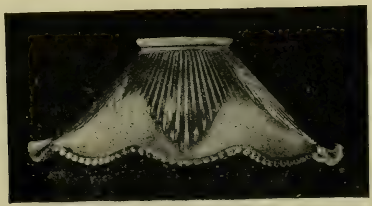

Fig. 8.
New Type of Partially Prismatic Reflector.

Types of Holophane Scientific Glassware.

A Portable Form of Photometer.

A PORTABLE type of instrument recently brought out by **Messrs. Hartman & Braun** (Frankfort a. M.), is shown in the two accompanying illustrations.

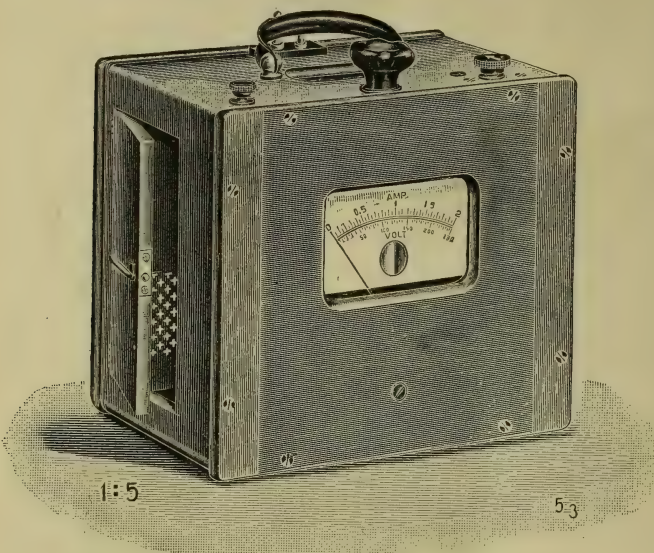

Fig. 1.

It is intended to enable a rapid estimate of the candle-power of a glow lamp, and also its current-consumption and the pressure of the supply to be determined. All the instruments necessary for this purpose are embodied in one self-contained piece of apparatus.

In making a test the lamp whose candle-power is to be determined is compared with a standard lamp supplied by the makers for the given voltage, the two lamps being placed in adjacent compartments as shown. The currents taken by the two lamps can be read in turn by moving the milled thumb-screw at the top right hand of the case either to the left or the right. If desired, the scale of the instrument can be calibrated direct in watts, or even money-values (*e.g.*. on the basis of 1,000 hours consumption, &c.).

The photometer portion of the instrument is shown in the section (Fig. 2) where L N is the standard lamp and L X the lamp under test, S1 and S2 two mirrors which reflect the light on to the two reflecting surfaces P1 and P2, the former of which is fixed to a different angle, and the latter is capable of adjustment by the centre knob on the top of the instrument (see Fig. 1). The intensity of illuminant due to the lamp LX can be varied by altering the angle of the reflecting surface P2. The top scale, showing the angular movement of the reflector, is calibrated to read the relative illumination values of the two lamps when the entire field of the sighting screen (on the front of the instrument) is equally illuminated; the scale of the movement of the reflecting surface can be calibrated in candle-power values for a definite light unit.

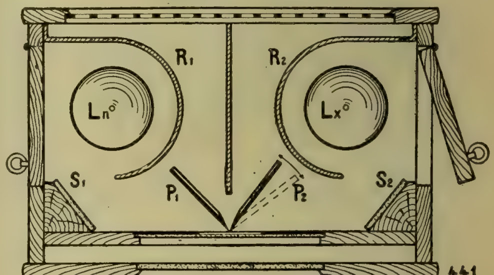

Fig. 2.

The total weight of the apparatus is approximately 10 lbs. Further particulars can be obtained from the **Union Electric Co., Ltd.** (Park Street, Southwark, London, S.E.) who are the agents of Messrs. Hartman & Braun, in the United Kingdom and the Colonies.

Signs, Shop-Lighting Fittings, &c.

WE have received from the **General Electric Co., Ltd.,** (71, Queen Victoria Street, E.C.), the latest list of shop-lighting fittings, illuminated signs, &c. The publication contains a number of patterns of strip-lights, lamps with metal reflectors for show-cases and pictures, &c., and reflecting shop-lanterns. In addition cluster lights of various patterns of the Holophane and other types and advertising arrangements of various kinds, including special electric flashing arrangements by which a sign can be lighted and extinguished at regular intervals, are shown.

Shaving Mirror and Lamp Combined.

THE convenient arrangement shown in the accompanying illustration is manufactured by the **Federal Electric Co.**, (Chicago, U.S.A.).

Its essential feature is that the light consists of a mirror 6¾ by 9 ins., made of the best French bevel plate mounted in a substantial easel frame with a cylindrical reflector at the base. This reflector is equipped with a tubular incandescent

can be directed so as to illuminate the region of the face which is being shaved without the light striking and dazzling the eyes. This, of course, necessitates very localized illumination. The article lamp, the rays from which are reflected through a horizontal opening. The reflector is movable and can be adjusted to reflect the light at any desired angle.

We are informed that **Messrs. G. M. Boddy & Co.**, of London, Liverpool, Sheffield, and Manchester, are extending their London premises, having taken over the building, 15, Gray's Inn Road, lately occupied by the Electro Motor & Dynamo Co., which business has been taken over by Messrs. J. & H. Grevener, of Eldon Street House, E.C. With these additional facilities, Messrs. Boddy & Co. state that they will be better able to deal with the demand for Metallik lamps.

The Cowper-Coles Engineering Co., Ltd. (82, Victoria Street, London), send us particulars of new types of MOTOR-CAR HEADLIGHTS fitted with the gold reflectors of the type recently exhibited at the trials of the Royal Automobile Club. The advantage of these reflectors, it is claimed, is that the tendency to dazzle is considerably reduced, owing to the fact that rays of a yellowish variety are less easily deviated by the atmosphere, and thus do not so readily form a halo.

The Municipal and Health Exhibition.

A MEETING of influential municipal officials and others interested in Local Government was held at the Holborn Restaurant on November 19th for the purpose of considering the advisability of holding an exhibition in May, 1910, representative of the varied work carried out by Municipalities.

The motion: "That this meeting heartily approves of and pledges its support to the Second Municipal and Public Health Exhibition, to be held in London in May, 1910, believing that this will be of material assistance to those who are responsible for the administration of Municipal Affairs and of immense educational benefit to the community generally" was moved by Capt. Riall Sankey, seconded by Professor Henry Adams, and carried unanimously. It was also decided that the exhibition should be named as above, that Local Committees and Secretaries should be appointed shortly, and that Local Government authorities should be invited to give their patronage.

During the meeting the list of gentlemen who had expressed their willingness to act on the Hon. Advisory Council was read, and we note that this contained the names of Mr. J. E. Edgcome, who is a member of the Council of the Illuminating Engineering Society, and of Mr. L. Gaster, the Editor of this journal.

Further particulars can be obtained from Mr. F. W. Bridges, Balfour House, Finsbury Pavement, London, E.C.

Another Model Electric Home.

THE tendency towards greater specialization in the education of the consumer in lighting matters is again exemplified by an exhibition recently opened by the South Metropolitan Electric Light and Power Co., Ltd., at Catford.

We note that a "Model Electric Home," where the most recent developments in electric lighting and heating could be seen, was exhibited.

The display was opened by a private view on November 25th, and we are informed that the model home in question is to be maintained as a permanent exhibition at Electra House, 111, Bromley Road, Catford, S.E.

Some Publications Received during the past Month.

The Incandescent Electric Lamp, by James Findlay, reprint of a paper before the Rugby Engineering Society.

A Rapid Review of Gas Manufacture in the City of New York for the past Fifty Years, by Dr. A. H. Elliott, reproduced from the *American Gaslight Journal*, Semi-Centennial Issue, July19th, 1909.

Publications of the Allgemeine Elektricitäts Gesellschaft, dealing with electricity-meters, A.E.G. arc lamps, &c.

The Prevention of Industrial Accidents, a pamphlet issued by the Fidelity and Casualty Company of New York.

Among other transactions and publications received we gratefully acknowledge the following:—*Annali della Societa degli Ingegneri e degli Architetti Italiani*, *Proceedings of the Am. Academy of Arts and Sciences*, *American Chemical Journal*, *Proceedings of the American Institution of Electrical Engineers*, *Proceedings of the American Philosophical Society*, *The Physical Review*, *Proceedings of the Institution of Civil Engineers (London)*, *Journal of the Institution of Electrical Engineers (London)*, *Journal of the Royal Society of Arts*, *Journal of the Society of Architects*, *Journal of the Franklin Institute*, *Transactions of the Faraday Society*, *Proceedings of the Tokyo Mathematico Physical Society*, &c.

Review of the Technical Press.

ILLUMINATION AND PHOTOMETRY.

The most important event of the past month has been the **Inaugural Meeting** of the Illuminating Engineering Society and Inaugural Address of the first President, which took place in London on Nov. 25th. Many of the gas and electrical papers comment favourably on the meeting and express good wishes for the future of the Society (see, for example, *Journal of Gaslighting, Electrician, Elec. Engineer, Electricity,* &c.).

There are also a number of editorials in the United States papers on general matters, some of them dealing with papers at the recent Convention.

Attention may also be drawn to several articles of exceptional interest in the German periodicals. Thus **Vogel** (*Z.f.B.*, Oct. 30, Nov. 10, 20) discusses the application of REFRACTORY OXIDES, &c., to the generation of light and heat, in a serial article, while another long contribution in the same journal deals, in a general manner, with recent developments in LIGHTING AND VENTILATION IN MINES.

There have also been several contributions on photometry. **Monasch** (*Elec. World*, N.Y., Oct. 28), contributes a letter discussing the precise meaning now to be attached to the term LUX, as compared with meter-kerze, on the Continent, and gives a table connecting the units of illumination in different countries.

J. S. Dow, in a paper before the Physical Society, describes some further EXPERIMENTS ON THE FLICKER PHOTOMETER, illustrating the fact that several physiological effects which are characteristic of instruments of the equality of brightness class are less pronounced in the case of flicker types. Thus both the Purkinje effect and the yellow-spot effect seem less marked.

J. Thovert (*Jour. de Physique,* Nov.) deals with SPECTROPHOTOMETRY. He discusses the principles underlying measurements of this class, and describes a form of instrument which can be used in conjunction with a photometer on an ordinary photometrical bench, thus rendering the comparison of the intensities of two illuminants, in any part of the spectrum, a convenient and simple process.

Lastly we may refer to several editorials on photometry in recent numbers of *The Electrical World.* One of these summarizes some of the difficulties of colour photometry, and another discusses the effect of deviations from the theoretical "point source" on the part of practical illuminants.

ELECTRIC LIGHTING.

A number of the articles appearing in the last month deal with the question of the RELATIONS BETWEEN SUPPLY COMPANIES AND THE CONSUMER and the effect of metallic filaments on the revenue of central stations. The matter receives attention in several of the American electrical journals, and some discussion has been raised in this country by a paper by **H. W. Handcock** and **A. H. Dykes,** read before the Institution of Electrical Engineers, on Nov. 25th. These authors fear a continued tendency towards reduction in the revenue of companies owing to the extension of metallic filament small candle-power lamps, and they propose to adopt a new system of charging based on the consumer's "contract demand," irrespective of the consumption of electricity.

An interesting declaration of the authors is that they foresee electric supply companies eventually undertaking the sale, not of electricity, but of *light.*

Several special devices have recently been described in the United States. Thus the RYAN SCINTILLATOR, which was largely employed in the Hudson-Fulton decorations in New York deserves notice. In this arrangement powerful searchlights, fitted with adjustable coloured diaphragms, are made to play upon specially manufactured clouds of condensing steam, which thus appear brilliantly illuminated. By suitably arranging the jets of steam, patterns, and mottoes, in heterochromatic hues can be produced.

Weedon (*Elec. Rev.*, N.Y., Oct. 23), briefly describes the TITANIUM ARC, from which an efficiency approaching some calculations of the theoretical maximum is expected.

Another interesting development is the FLUID-ELECTRODE ARCLAMP, in which the materials for the electrodes are fed in a more or less pasty condition and gradually baked to the required consistency as they approach the points where the arc is burned (*Elec. Rev.*, N.Y., Nov. 6.)

A general article on electrical street lighting in the *Journal für Gasbeleuchtung* is chiefly interesting on account of its appearing in a gas journal; conversely it will be seen that the *Elektrotechnische Zeitschrift* has an article on electrical igniting devices for gas lamps.

GAS, OIL, AND ACETYLENE LIGHTING.

The gas journals in this country continue to discuss the proposed Bill specifying a common testing burner throughout the country. The suggestion is regarded as a considerable simplification and receives powerful support.

A number of articles in the American press treat upon the relations between the company and the consumer; in all cases a policy of conciliation and friendliness is supported and descriptions are given of methods of getting in personal contact with dissatisfied customers, when difficulties are usually smoothed out to the mutual satisfaction of both parties.

Special interest attaches to the address recently delivered by **Mr. Corbet Woodall,** who made reference to the question of the education and training of the gas engineer. Many will appreciate the wide wisdom of much of this address, particularly the terse emphasis placed on the fact that all education is directly proportional to the efforts of the seeker after knowledge. All that can really be done is to place the sources of education at a man's disposal.

H. N. Clark recently delivered an interesting paper on gas lighting (*G.W.*, Nov. 6). The remarks on the relative costs of gas and electric lighting cover fairly familiar ground. The speaker, however, made special reference to the introduction of high pressure gas in shop-lighting and to the field available for gas (which has not yet been adequately developed), for illuminated signs. Special reference was also made by the lecturer, and by some who took part in the discussion, to the policy of free maintenance and the sale of mantles to consumers, a notable example being the system successfully adopted by Mr. Helps at Croydon.

A recent contribution by **M. Scholz** (translated in abstract in the *J.G.L.*) contains a summary of progress in INVERTED LIGHTING; it is interesting to note that the average life of the mantles used for the public lighting of Berlin is given as 200 hours.

Attention may also be drawn to the particulars of the LIGHTING OF THE ALEXANDRA PALACE (London), which has recently been converted to high pressure.

Yet another instance of an electrical journal dealing with gas lighting is furnished by *The Electrical Review* (New York), a recent number of which, it will be observed has an editorial dealing with NATURAL GAS.

Lastly attention may be drawn to a series of articles on AUTOMATIC IGNITION DEVICES. Thus the "Fiat Lux" controller is described in a recent number of *The Gas World*, and another system in the *Journal für Gasbeleuchtung* (Nov. 13) **Wendt** (*E.T.Z.*, Nov. 4) describes electrical methods, and recent numbers of the *Zeitschrift für Beleuchtungswesen* complete the long and complete serial article in which all methods have been described in turn. The most recent numbers deal with electrical and chemically working systems.

ILLUMINATION AND PHOTOMETRY.

Bernoulli, Dr. R. Beleuchtungskunst (*Z. f. B.*, Nov. 10).

Cravath, J. Recent Progress in Illuminating Engineering (*Elec. World*, N.Y., Oct. 28).

Dow, J. S. The Theory of the Flicker Photometer (paper read before the Physical Society, London; see also *J. G. L.*, Nov. 2-16).

Editorials. The Art of Illumination (*J. G. L.*, Nov. 23).
Art in Public Lighting (*Elec. Rev.*, N.Y., Nov. 13).
The Light of the Firefly (*Elec. World*, N.Y., Oct. 14).
Illumination Problems (*Electrician*, Nov. 26).
Illumination (*Electrical Engineer*, Nov. 26).
Some Errors in Testing Sources of Light (*Elec. World*, N.Y., Oct. 14).
Colour-Photometry (*Elec. World*, N.Y., Nov. 4).

Monasch, B. The Lux as a Unit of Illumination (*Elec. World*, N.Y., Oct. 28).

Owens, H. T. Illuminating Engineering in Europe (*J. G. L.*, abstract, Oct. 26; *Am. Gaslight Jour.*, Oct. 18).
Street Lighting Abroad (*Elec. Rev.*, N.Y.. Nov. 13).

Thovert, M. J. Spectrophotomètres et Photométrie des Sources Colorées (*Jour. de Physique*, Nov.).

Vogel, O. Die feuerfesten Stoffe und die Heizungs und Beleuchtungstechnik (*Z. f. B.*, Oct. 30; Nov. 10, 20).
New York Section of the Illuminating Engineering Society Meeting (*Elec. Rev.*, N.Y., Oct. 23).
The Illuminating Engineering Society (*J. G. L.*, Nov. 23).
The American Illuminating Engineering Society (*J. G. L.*, Nov. 2).
The Study of Colour (*The Gas Engineer's Magazine*, Oct. 15).
Fortschritte im Beleuchtungs und Luftungswesen des Bergwerkbetrieben (*Z. f. B.*, Oct. 30, Nov. 10, Nov. 20).

ELECTRIC LIGHTING.

Adams, A. D. Population, Consumers and Lamps (*Elec. World*, N.Y., Nov. 4).
Editorials. The Counter E. M. F. in the Electric Arc (*Elec. World*, Oct. 28).
Lighting Load and Population (*Elec. World*, N.Y., Nov. 4).
The Present Aspects of Electric Lighting (*Elec. Rev.*, Nov. 26).
Handcock, H. W., and Dykes, A. H. The Present Aspects of Electric Lighting. (Paper read at the Institution of Electric Engineers, London, Nov. 25)
Robb, A. Electric Lighting of Trains (*Elec. Engineer*, Nov. 5).
Webber, W. H. Y. The Prospects of Electricity in Domestic Service (*G. W.*, Nov. 13).
Weedon, W. S. The Titanium Arc (*Elec. Rev.*, N.Y., Nov. 6).
The Ryan Scintillator (*Elec. Rev.*, N.Y., Oct. 23).
Uber elektrische Strassenbeleuchtung (*J. f. G.*. Nov. 6).
Esparnis an Betriebskosten durch lange Brenndauer der Intensiv—Flammenbogenlampen (*Z. f. B.*, Nov. 20).
A Fluid Electrode Arc Lamp (*Elec. Rev.*, N.Y., Nov. 6).
Multiple Tungsten Streetlighting (*Elec. World*, N.Y., Oct. 14).
A Village Lighting Scheme (*Elec. Review*, Nov. 19).
Electric Lighting in Small Towns and Villages (*Electrician*, Nov. 12).
The Welsbach Metallic Lamp Legal Action (*Elec. Engineering*, Oct. 28, Nov. 4, Nov. 11).
Gas *v.* Electricity (*Elec. Rev.*, Nov. 26).

GAS, OIL, AND ACETYLENE LIGHTING, &c.

Baker, W. J. R. Aspects of Recent Competition (*G. W.*, Oct. 23).
Barrett, C. L. The Public's Complaints (*Prog. Age*, Nov. 1).
Baurhyte, W. Methods of Educating Consumers (*Prog. Age*, Nov. 1).
Clark, H. N. Notes on Gaslighting (*G. W.*, Nov. 6).
Clements, J. Some Results of Personal Interviews with Dissatisfied Consumers (*Am. Gaslight Jour.*, Nov. 8).
Dixon. H. B. The Chemistry of Flame (*J. G. L.*, Nov. 9, *G. W.*, Nov. 13).
Editorials. Joint Bill for the New Test-Burner (*J. G. L.*, Nov. 2, *G. W.* Nov. 6).
Natural Gas (*Elec. Rev.*, N.Y., Nov. 6).
McBeth, N. Illuminating Engineering with Gas, Discussion (*Am. Gaslight Jour.*, Nov. 1).
Scholz, M. Advances in Inverted Gaslighting (*J. G. L.*, Oct 26).
Wendt. Elektrische Gasfernzünder (*E. T. Z.*, Nov. 4).
Woodall, C. Address before London Southern Jr. Gas Association (*G. W.*, Oct. 30).
Starklichtlampe ohne Pressgas (*J. f. G.*, Nov. 6).
Gastesting in London (*J. G. L.*, Oct. 26).
The Lighting of the Alexandra Palace (*J. G. L.*, Nov. 16).
Illuminated Signs (*G. W.*, Oct. 30).
The Fiat Lux Controller (*Gas World*, Oct. 30).
Versuchsanatalt für Gasbeleuchtung in Wien (*J. f. G.*, Oct. 30).
Antifax angeblich ein Mittel zur Erhöhung der Haltbarkeit von Glühkörper (*J. f. G.*, Nov. 13).
Apparat zum selbsttätigen Zünden und Löschen von Gaslampen (*J. f. G.*, Nov. 20).
Gaszündvorrichtungen, Elektrische Zünder (*Z. f. B.*, Oct. 30, Nov. 10); Chemisch wirkend Zünder, *Z. f. B.*, Nov. 20).
L'Industrie de l'Acétylène en Amérique (*Rev. des Eclairages*, Oct. 30)
Art, Colours and Acetylene (*Acetylene*, November).

CONTRACTIONS USED.

E. T. Z.—*Elektrotechnische Zeitschrift.*
G. W.—*Gas World.*
Illum. Eng., N.Y.—*Illuminating Engineer of New York.*
J. G. L.—*Journal of Gaslighting.*
J. f. G.—*Journal für Gasbeleuchtung und Wasserversorgung.*
Prog. Age.—*Progressive Age.*
Phys. Rev.—*Physical Review.*
Z. f. B.—*Zeitschrift für Beleuchtungswesen.*

An Important Patent on Scientific Glassware Upheld.

A German correspondent sends us the following particulars regarding the result of the suit of annullity lodged by Campe & Co., of Berlin, against the German Patent 166828 of O. A. Mygatt, of New York:—

On June 25th, 1908, a verdict was rendered by the Imperial Patent Office in favour of the above patent. The plaintiffs in this case appealed against the above decision, and a hearing was held in the Reichsgericht (first civil senate), in the building of the Reichsgericht at Leipzig, Germany, on the 23rd of October, 1909. The Court of seven judges upheld the decision of the Imperial Patent Office, and decided in favour of the patentee, O. A. Mygatt, and sustaining D.R.P. 166828.

The Reichsgericht at Leipzig is the highest court on patent matters in the German Empire.

PATENT LIST.

COMPLETE SPECIFICATIONS ACCEPTED OR OPEN TO PUBLIC INSPECTION.

I.—ELECTRIC LIGHTING.

22,454/08. Arc lamps. Oct. 22, 1908. Accepted Oct. 27, 1909. S. C. Mount, 27, Chancery Lane, London.

23,053. Supporting lamp brackets, &c.. on walls. Oct. 29, 1908. Accepted Oct. 27, 1909. J. J. Rawlings, 34, High Holborn, London.

24,212. Lamp filaments (C.S.). I.C. Nov. 12, 1907, France. Accepted Nov. 17, 1909. Soc. Française d'Incandescence par le Gaz (Système Auer), 24, Southampton Buildings, London. Addition to 12,720/08.

26,205. Detachable lock for bayonet-catch lamp holders. Dec. 4, 1908. Accepted Nov. 3, 1909. C. F. H. Bayly, 13, Priory Hill, Dartford.

27,729. Ceiling roses, &c., for use in electric circuits. Dec. 21, 1908. Accepted Nov. 3, 1909. F. G. Bazell and R. B. Verney, 18, Hertford Street, Coventry.

299/09. Locking lamps in their holders. Jan. 6, 1909. Accepted Nov. 17, 1909. T. McClelland, jun., 7, Corrie Grove, Muirend, Cathcart.

430. Fittings for incandescent lamps. Jan. 7, 1909. Accepted Nov. 3. 1909. F. W. Suter, Chancery Lane Station Chambers, London.

667. Metal filament lamps. Jan. 11, 1909. Accepted Nov. 17, 1909. J. Meszaros, 20, High Holborn, London.

1,541. Preventing flickering in parallel carbon arc lamps (C.S.). I.C., July 18, 1908, Germany. Accepted Nov. 3, 1909. D. Timar and K. von Dreger, 7, Southampton Buildings, London. Addition to 12,656/08.

3,836. Portable electric light fittings (C.S.). Feb. 16, 1909. Accepted Oct. 27, 1909. L. A. Williamson, 7, Southampton Buildings, London.

4,694. Lighting system with lamps in series. Feb. 25, 1909. Accepted Nov. 10, 1909. C. H. Stearn and C. F. Topham, 47, Lincoln's Inn Fields, London.

7,092. Non-carbon filaments (C.S.). March 24, 1909. Accepted Oct. 27, 1909. W. Heinrich, Palace Chambers, Westminster.

7,913. Glow lamps (C.S.). April 2, 1909. Accepted Oct. 27, 1909. F. Färber, 345, St. John Street, London.

11,578. 11,579. } Arc lamp (C.S.). I.C., Sept. 22, 1908 and June 30, 1908, Germany. Accepted Oct. 27, 1909. B. Duschnitz, 77, Colmore Row, Birmingham.

II.—GAS LIGHTING.

1,791/08. Mantles and holders for incandescent lighting. Oct. 15, 1908. Accepted Oct. 27, 1909. H. S. Thompson, 4, Corporation Street, Birmingham.

21,961. Burners for lighting and heating. Oct. 17, 1908. Accepted Oct. 27, 1909. G. Wardle, 60, Lever Street, London.

24,757. Globe carriers for inverted incandescent lamps. Nov. 18, 1908. Accepted Oct. 27, 1909. H. Gibbs and W. Daley, Carlton Buildings, Paradise Street, Birmingham.

2,630/09. Gas-cocks for automatic light-controlling systems. Feb. 3, 1909. Accepted Oct. 27, 1909. E. Sparks, 60, Queen Victoria Street, London.

3,948. Inverted incandescence lamps (C.S.). I.C., Feb. 17, 1908, Germany. Accepted Nov. 3, 1909. E. W. Küttner, 4, South Street, Finsbury, London.

5,010. Incandescent mantles (C.S.). I.C., Feb. 6, 1909, Germany. Accepted Nov. 10, 1909. Rhenania Gluhlicht Compagnie, G.m.b.H., 111, Hatton Garden, London.

9,740. Anti-vibration burner for incandescent mantles. April 24, 1909. Accepted Oct. 27, 1909. J. Dulton and W. A. Newhouse, 24a, Church Bank Buildings, Bradford. Addition to 6,700/09.

10,745. Incandescence bodies for gaslighting (C.S.). May 6, 1909. Accepted Nov. 10, 1909. M. Weickert, 37, Essex Street, Strand. Addition to 2,572/08.

24,443. Incandescent mantles (C.S.). I.C., Nov. 3, 1908, France. J. L. Muller and J. Bonnet 111, Hatton Garden, London. Addition to 6,556/09.

25,081. Gaslighting apparatus (C.S.). I.C., Nov. 6, 1908, Germany. Gas-Laternen-Fernzündung' System Dr. Rosten, G.m.b.H., 6, Bank Street, Manchester.

III.—MISCELLANEOUS.

(including lighting by unspecified means, and inventions of general applicability).

22,319/08. Illuminated signs, &c. Oct. 21, 1908. Accepted Oct. 27, 1909. R. F. Venner, 20, High Holborn, London.

24,793. Automatic igniters and extinguishers (C.S.). Nov. 18, 1908. Accepted Nov. 3, 1909. M. W. Bröndun, 345, St. John Street, London.

28,498. Incandescent vapour lamps (C.S.). Dec. 31, 1908. Accepted Oct. 27, 1909. M. Galvas, 70, Chancery Lane, London.

2,999/09. Oil vapour burners for incandescent lamps (C.S.). Feb. 8, 1909. Accepted Nov. 10, 1909. Gas Economising and Improved Light Syndicate, Ltd., J. Wilkie and O. P. Macfarlane, 139, Queen Victoria Street, London.

19,775. Pyrophorous lighting devices (C.S.). I.C., Oct. 15, 1908, Germany. Bochum Lindener Zundwaren und Wetterlampenfabrik C. Koch, 111, Hatton Garden, London.

21,224. Incandescence vapour lamps. D.A., Sept 30, 1908. Accepted Nov. 17, 1909. Kitson Empire Lighting Co., Ltd., and R. H. Stephens, Birkbeck Bank Chambers, Southampton Buildings, London.

EXPLANATORY NOTES.

(C.S.) Application accompanied by a Complete Specification.

(I.C.) Date applied for under the International Convention, being the date of application in the country mentioned.